THE

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STEAM v. WATER-POWER FOR ELECTRIC GENERATING PLANTS.

ONE of the most important developments of the year 1905 relates to the closer competition which has arisen between steam-engine-driven and water-power electric generating plants.

With good coal at 12s. per ton, ample water supply for condensing purposes, and a sufficiently large market for the product, electrical energy can be manufactured in bulk in modern steam-driven generating stations, and profitably retailed to the smallest customers at about 1d. per unit, and to large customers with favourably timed loads, at from 0·5d. to 0·75d. per unit. The distance from the generating station also affects the price, a considerable component of which represents interest and depreciation on the capital invested in the transmission system.

These prices would permit of doing a profitable business in almost any industrial city in the world with a population of not less than 600,000, provided only that consideration for vested interests should not stand in the way of introducing strictly modern plant and methods. The great reduction in the requisite capital outlay, and in the running costs, in the case of steam-driven stations is in no small measure due to recent improvements in high-speed piston engines, and in steam turbines, together with the more general use of superheated steam.

The emergence of these figures as attained and attainable with steam-driven electric generating stations, relegates hydro-electric generating undertakings to a much more restricted field than they have hitherto occupied. While the total capital cost of steam-driven generating stations, of a capacity of from 100 millions of units per year upwards, is well within £13 per rated kilowatt of generating sets installed, the total capital cost involved in developing a water-power, comprising the hydraulic engineering work and the electric generating station and plant up to the outgoing transmission line, is generally at least twice the above figure, and often much greater. Now, in the modern steam-driven generating plant, with a capacity of not less than 100 million units per year, and with coal at some 12s. per ton, and with a 50 per cent. load factor, the total generating costs as distinguished from total generating and transmitting costs, are made up somewhat as follows:—

Fuel, oil, waste, stores, labour, administration, insurance, taxes, &c., 50 per cent. of total generating costs.

Depreciation and interest on capital expenditure for generating plant, 50 per cent. of total generating costs.

Now, obviously, since water-power electric generating plants may, as a conservative average, be taken as entailing twice as great capital outlay per unit generated, there remains no margin of advantage. Indeed, the water-power plants have the great disadvantage of the enormous additional capital outlay for the long-distance transmission line from the water-power to the market. For it is in the nature of

things that, whereas large water-powers are in mountainous regions, the great majority of large cities are situated at the sea coast or on the banks of large and navigable rivers or lakes. In the case of Niagara, the water-power has afforded the inducement for the formation of a city. Shawinigan Falls has attracted large factories. These, however, are two amongst the limited group of exceptions, and were, furthermore, more or less accomplished facts before the development of the possibilities of steam-driven stations. Promoters conversant with recent and prospective developments in steam-driven generating stations are rightly inclined to canvass the situation far more thoroughly than formerly before embarking upon hydro-electric generating stations. It is doubtful whether, even in countries such as Italy and Mexico, where coal is expensive, hydro-electric undertakings when involving long-distance transmission lines would often be found justifiable when considered in the light of the most recent developments in steam generating plant. The disadvantage of the hydraulic scheme need not necessarily be very great. This will depend largely upon the outlay involved in civil engineering work in order to utilise sufficient of the available hydraulic power in generating electric power, expressed in terms of the capital expenditure per million units generated per year. It will, furthermore, depend largely upon the interest and maintenance costs of the high-tension transmission line, hence also upon its length.

Even in the case of steam-driven generating stations, however, the capital outlay for the distribution system is, in large cities, no small item. It will generally at least equal the total outlay for the generating station, and will not infrequently be more than twice as great. Altogether, it must be very evident as the result of the considerations here brought together, that the fuel cost in the case of modern steam-driven generating plants, instead of being the largest item, and instead of justifying great outlay if only it can be avoided by calling into service some more or less distant water power, is a comparatively minor consideration as affecting the commercial prospects of a large modern electric supply undertaking, and is consequently a relatively minor consideration in determining the price. Thus were there two undertakings identical in all respects except as to the price of coal of a given quality, and were the price 6s. per ton in the one case, and 12s. per ton in the other, it would not affect the price to the customer by anything like 50 per cent. In a large city with a necessarily expensive system of underground cables, the effect on the price per unit of electric energy occasioned by doubling the price of coal would be more of the nature of 10 to 15 per cent. for this range of prices, although the percentage would increase with an increase in the mean price of coal, other conditions remaining the same.

Improvements in the efficiency of operation, and decrease in the capital cost of steam-driven electric generating plant, must inevitably result in restricting the field for hydro-electric generating plants. In England, where proprietary rights run into higher figures than in other countries, these considerations would act with especial force were there any water-powers worth mentioning. Even in unsettled countries like South Africa, however, extra long-distance transmission cannot compete with thoroughly modern steam-driven plant.

General impressions in these matters are still too greatly controlled by the influence of the antique undertakings on which most of us are still forced to rely for our supply of light and power. Happily, however, not only has the immediate future in store for us electrical energy for light and power at but a fraction of the price we are now paying, but this price will be so low as to permit of the extensive introduction of electric heating and cooking. This latter development will effect a more radical improvement than is generally realised in the conditions of modern life. That it is imminent, there is, however, no longer the slightest doubt.

The General Election.

In another part of the current issue we print a communication from Mr. W. Pollard Digby, which tends, by its attempt to describe the logical ends of protection, to burlesque the present outcry. From party politics, the technical Press desires to be delivered; it has no wish to find itself between the anvil of protection and the steam hammer of retaliation. It has no concern in half the cries of party politics. Engineers, as citizens, have their own views on the political cries respecting the administration of Ireland, or the utility of Chinese labour, or the religious aspect of the education controversy. Professionally, these are of no concern to the engineer. A question like that now termed "fiscal" stands in a different category, for in it is wrapped up the question of our commercial supremacy. Therefore, despite the forces which tend to separate party politics from the scope of the contents of an engineering journal, the technical Press has been compelled to notice the question. We print Mr. Digby's article, not as an endorsement of the views he expresses, but as illustrating the extreme complexity of the question, in that it shows how conflicting are the trade interests of the country.

Another side of politics also directly concerns the engineering profession, although it is not yet a party question. Before the turmoil due to the fiscal question has rolled away, some legislation for dealing with municipal expenditure will be a necessity. Engineers, as citizens, might do worse than ascertain the views of those seeking their votes on this exceedingly important question, and support only those holding sound and sane views on the economic side of municipal expenditure.

Our Canals.

It is satisfactory to find that there appears to be a continuity of policy in respect of the canal question. Lord Lansdowne set on foot inquiries concerning the canal systems of the Continent in 1901; then in April last he inquired for further information to bring the matter up to date, and a further series of reports was issued last week, from which it appears that the German canal scheme published last year contemplates an expenditure of nearly 17 millions sterling upon canals, of which over 12 millions will be absorbed on the canal between the Rhine and the Weser, and the remainder will be divided between a canal from Berlin to Stettin, and another between the Oder and the Vistula.

France has works in progress to cost over £8,000,000, including a canal from Cette to the Rhone, and one from Marseilles to the Rhone. Belgium and Holland are both spending considerable sums on canals. As with the railways of the Continent, so many of which are under State control, so also is it with the canals. We do not understand why the *Engineer* should take so hopeless a view of the prospects of canals in this country. Because they have been strangled and neglected by the railways which secured control of them is no proof that canals did not and will not pay. Nor is it even necessary to infer that the cost of revivifying them need necessarily fall upon the country—*i.e.*, that the canals can only be made good by Government aid. Our railways in no instance are in the hands of Government. Private enterprise has done what abroad is done by Government, and there seems no good reason why the same should not be repeated in the case of our canals.

We observe that the Premier has stated it as his intention to appoint a Royal Commission to inquire into the canal question generally. The matter is one in which men of both political parties can agree, so that it is hardly likely to become a party question. Indeed, one could almost hope that it might become so in order that some party energy and publicity might be given to it.

That the cost of carriage in this country is excessive none can doubt. Our railways were made in days when trade was exposed to less competition than to-day and the present system of railway management grew into being. Traders who have to deal with the railways, however, can tell us much of their shortcomings; how they break and destroy goods for lack of cranes; how they lose all manner of stuff, and have to pay for it, entirely on account of bad management. If they would bestir themselves, there can be no doubt the railways

would do much better than they are doing. But in any case it can scarcely be held right that the whole industry of the country should be butchered to make a railway holiday, and it is evident enough that foreign facilities for cheap carriage, aided by the preferential rates on foreign produce granted by English railways, are very much to blame for the competition of the foreigner. Practically speaking, our railway charges are by way of being an export duty on our productions, for whichever way he moves the home manufacturer is faced with unfair treatment by our home railways.

There should be some way by which Parliament can grant powers to take over the present canals at their present real value, to some body of capitalists, so that a modern system may be evolved. There should be no extortion; there ought to be no attempt to demand fancy compensation on the part of those who have deliberately, and of set purpose, reduced the value of the canals to vanishing point. We have seen electric tramways crippled by the constant accretion of capital, each new system piling a load of fresh capital on the top of the previous capitalisations of horse and steam-worked lines in succession. This overloading should not be permitted with the canals. They are practically derelict, their banks sliding away into their beds, their locks rotted to uselessness, and their overbridges mere little stone-bows in this day of 300 and 1,000-ton barges. Indeed, our canals are so old and so long untouched, that many miles of them have been taken into the embrace of nature, and it is hard to demark the junction of the artificial and the natural. They are pretty and picturesque water by-ways fitted for the brush of a Constable, but not of the slightest good to the trade of England. Nor can it really be considered that their resuscitation in a modern guise would do any harm to the railways. These might be wakened up, it is true. The greatest threat of modern times against the railways was the Manchester Ship Canal. The railways fought tooth and nail against it, yet this great Ship Canal has remade Manchester, and poured thousands into the coffers of the railways, which had already begun seriously to suffer from the decay of Manchester. Can any one of sound sense deny that an equally beneficial result would accrue from the development of trade that would follow on cheap water carriage?

A Startling Workmen's Compensation Case.

The case of Hatfull *v.* Greenwood and Co., which was reported in the *Times* of December 19th, is one of the most remarkable which has been decided under the Workmen's Compensation Act. It appears that one Hatfull, a stone mason, died in consequence of an accident whilst in the employment of the defendants. His wife had died four days before. He left three daughters and a son, all over age. One of the daughters had acted as his housekeeper, and another had helped her mother in a dress-making business. The son, who was 28 years of age, had not worked for 18 months, but prior to that time he had been earning 25s. a week. These "children" preferred a claim for compensation under the Act on the ground that they were dependents. His Honour Judge Rentoul said he had grave doubts as to whether Parliament intended to benefit as dependents the grown-up children of workmen who met with accidents, and he had reserved judgement, having regard to the novelty of the case. In the event he decided to award £100 to each of the daughters, but nothing to the son. But why, it is asked, should he have drawn a distinction between the son and the daughters? It has been decided again and again that a father may be dependent upon his son, and therefore entitled to compensation; but, so far as can be ascertained, there is no precedent for the decision given by his Honour Judge Rentoul. His finding, too, is one of fact, which cannot be disputed in a higher Court. Truly the Act of 1897 is a marvellous piece of legislation!

Fly-Wheel Explosions.

Insurance Engineering says that from July 11th to September 12th there were in the United States no fewer than 16 fly-wheel explosions. This is at the rate of 100 per year. Now the United States is not noted as the home of particularly fast-running steam engines, so that the failure of so many wheels must be sought for in some other cause. Either fly-wheels are badly put together, or there is some reason why steam engines run away more frequently than they do here, where a burst fly-wheel is somewhat of a rarity. We are inclined to think that both causes are contributory, and that there is some want of provision against the effects of an over-running engine, and some carelessness or slipshodness in fly-wheel construction which conjoin to produce so many disasters. Yet nowhere have more or better tests been made than in the United States in the way of testing small model wheels to destruction, so as to find out the special weaknesses of various forms of rim joints and arm connection. A writer in *Power* believes that all the fly-wheel bursts are due to over-running of the engines, and not to faults of the fly-wheels. If so, there must be something very faulty in the governing of American engines, or in the provision of knock-off motions.

A New Calumny.

At the recent meeting of the British Association of Waterworks Engineers in London, a paper was read by Mr. Baldwin Latham, in which a charge of electrolysis of a water pipe was brought forward on the flimsiest foundation. The circumstances were briefly as follows:—Twyford Lodge, Hants, is provided with an electric lighting installation carried out under the supervision of Messrs. Handcock & Dykes, on the concentric system, with an earthed return. The latter, however, is earthed only at the house; the bare copper return conductor is embedded in bitumen alongside the positive main between the house and the engine room, a considerable distance away. A water pipe connected with the South Hants Waterworks feeds both the house and the engine room, and therefore runs roughly parallel with the electric mains; the latter cross the former near the engine room. Obviously, if any stray current entered the water-pipe at the earthed end (at the house, that is), it must leave the pipe near the engine room. But the pipe was examined and found to be uninjured, a fact admitted by the Waterworks Co. Moreover, as above mentioned, there is no earth connection at the engine room.

Now, for four years after the foregoing conditions were established, all went well; but nine months ago a ¾-in. lead service pipe was laid from the water main near the engine room to a cottage some 100 yards away from the engine room. In October last a case of lead poisoning occurred at the cottage, and on examining the service pipe, it was found to be corroded. The allegation was then put forward by the author of the paper that the corrosion was due to electrolysis, presumably because there was a dynamo within a quarter of a mile of the spot. Be it noted that the service pipe affected ran out to a dead end, and could by no possibility whatever form part of a return circuit for stray currents.

But we have kept the cream of the joke to the last—it is too good to be missed. *The whole of the corrosion took place on the inside of the pipe!!*

Need we say more?

We have personally examined a portion of this pipe; it is encrusted in spots—inside—with patches of white salt, presumably lead carbonate, and these patches lie mainly along a narrow longitudinal area, which, doubtless, was either at the top or at the bottom of the pipe. The patches are otherwise isolated, and while they are just the sort of thing that would be met with in a case of chemical corrosion, they do not in any way suggest the uniform distribution that would result from electrolysis. Between the patches the pipe is bright and clean. The outside of the pipe is perfectly uninjured.

The pipes were found to be practically at the same potential as the earthed conductor, the maximum reading being 0·2 volt, which could be obtained in the middle of a desert. When the maximum current was passed through the mains, a pressure of 1·8 volts was observed between the negative conductor and the pipe at the engine room, and to this a firm of consulting engineers attributed the whole trouble! Yet they offered no explanation for the fact that the trouble occurred, not on the parallel line of pipes, but on a spur a long way off—and on the inside of the pipe! Truly this is the most preposterous attempt to make electricity the scapegoat that we have ever met with.

D

PROTECTION IN EXCELSIS.

By W. POLLARD DIGBY.

Now that a General Election is to be waged over the question of Protection, Retaliation and Free Trade, a few words on the engineering side may not be inappropriate. On the one side, there is the protectionist renaissance, with its appeals couched in different terms to different industries, these appeals being incapable of being synchronised for the common weal; on the other side, an existing fiscal system which is not immaculate, but which, regarded in the light of economic laws, gives the maximum of all-round justice. Between them is a half sheet of notepaper capable of interpretation in either light. On the one hand, there is a huckstering system of preferences which are to knit an Empire more firmly than kinship, or trade tradition, or mutual ideals. Beside the half sheet of notepaper is an antiquated blunderbuss termed retaliation, which, in some eyes, is as dangerous to the user as to those against whom it is aimed. On the side of the existing system is a demand for cheap raw material, without which no industry can exist; and, seeking to return to Westminster, is a body of legislators who, as Mr. Swinburne recently said in another connection, "think that if a manufacturer does not pay, the simple expedient of raising the price will put things right."

Before dealing with the Imperial side of the fiscal question, the root question of what constitutes raw material may be discussed. The agricultural advocates of the propaganda claim that it, at any rate, should not be overlooked. The farmer and his labourers desire full occupation and high prices. Their demand is that competition from other sources shall be so restricted as to secure their desires. If the dairy farmer in Somersetshire is to be ousted from the prosperity he desires by over-sea produce, it will make little difference to his bank book, whether that produce be Colonial or Continental in its origin. If preferences raise the price of his commodities, well and good for him; if they do not, he is no better off than before. The alluvial lands on which he grows his crops, or upon which his cattle graze, are the foundation of his industry. A striking parallel to the farmer is that of the owner, say, of a large deposit of iron ore. Geologically speaking, the iron ore bed is the older strata, but the nitrogeneous products of the soil which go to feed whole armies of artisans, bear a striking resemblance to the various ores which go to feed the once-flaming furnaces of the ironmaster. Without food, home or foreign, populations must starve; while without ore, home or foreign, blast furnaces become cold landmarks, as useless industrially as so many monoliths. The iron ore producer has not yet asked for protection. Perhaps his sense of the futility of such a demand has restrained him. Yet in the measuring out of bare justice, there is as much weight due to his requests as to those of the larger landed interests. In a summing-up the counsel for the iron ore claimants would declare that his clients employed British labour, and that if their neighbour, the corn grower, needed to be protected against the huge imports of wheat from the more prolific acres of Egypt or Argentina, his clients needed protection against the dumping into the hungry mouths of the adjacent furnaces of the ore mined in the richer beds of northern Spain.

The furnace owner who consumed the ore would say that, in his endeavours to supply the world with pig-iron, it was of vital interest to him that he should secure abundant supplies of cheap ore, containing the minimum amount of impurities. If any imports needed to be taxed, let it be that of the pig-iron which competed with him. Going a stage further, the steel founder would protest energetically against the granting of any monopoly to the pig-iron maker. He required pig-iron of certain definite composition, and this must be abundant and cheap. He would, of course, like to be protected against the dumping of Pittsburg or Westphalian billets; indeed, he *ought* to be protected against the ruthless foreigner who was ruining *his* trade by underselling *him*. The owner of the rolling mill would then have to intervene. To keep *his* rolls busy, his raw material, although the finished product of the steel foundry, must be unlimited. To *his* rolls it made no difference whence the billets came, but billets he must have and have cheap, else his capital would be wasted, and *he* must discharge *his* employés. Not only had he to sell angle iron, rails, and sheets for multifarious purposes in Great Britain, but he had to face competition in the neutral markets of the world. If *his* rivals, German or American, had cheaper raw material, *he* could not maintain *his* hold on these. At the same time, his capital, his industry, his workpeople, must be protected against the scandalous manner in which certain competing goods were being sold to shipbuilders at less than the cost at which he could produce them. The shipbuilder chiming in would very naturally point out that shipowners required cheap ships, that he built ships not only for British shipping firms, but for Japan, Holland, Sweden, Germany, and other countries. British shipping firms were in the habit of selling their old ships to foreign owners, replacing them with new, cheap and more efficient vessels built in his own yards. Any shipbuilder on the Clyde, Tyne or Wear would urge that the form of protection which he required was delivery from would-be monopolists who would charge him more for rivets, plates or angle iron. The justly aggrieved shipbuilder might cite the First Enquiry Blue Book (Cd. 1761) which, on page 360, states that "the wages outlay of the shipbuilder is from 33 to 40 per cent." and urge that more labour was expended in the shearing, drilling and riveting of a ton of plates to the frame of a ship, than was required for the rolling of these plates. Also, there was not only the ship to consider, but the engines and boilers which were a product whose value could not be expressed in cwts.—except when after years of use they had come to the scrap heap category—but in many weeks of highly skilled labour and highly trained brains.

In the foregoing paragraph I have traced some of the interests which would be dislocated, and which would be awakened into hostility (hostility garbed as lobbying, along the lines inseparably associated with Tammany Hall) upon the position of any tariff on only a section of the engineering industry. If other industries be examined, one has only to go a very little below the surface to discover similar potentialities of conflicting interest. Turning to cotton, those who bleach cotton yarn very naturally buy their raw material—chloride of lime—at the cheapest price. The British chemical manufacturer, who supplies a large portion of their needs at a price which is diminished by foreign imports, would, if commercial plunder became the keynote of our administration, be glad to obtain higher prices, which must either increase the selling price of the weaver's produce or diminish the weaver's profit. The spinners and weavers thus harried and harassed in a hundred petty ways (to say nothing of the crux of the question, the increased price of food), would find little solace in securing an impost on foreign-made cotton goods entering the United Kingdom. They might, however, demand that the Lancashire engineering firms should cease to export any more textile machinery to Germany, France, America, Japan, India or Canada. Protection consistently pursued to its extremest end should preclude their neighbours from arming their commercial rivals. When a state is at war, either with another power or with border tribes inclined for raiding, the sale of munitions of war to an open foe of its population is an act of treachery with which the law severely deals. If we are to be protectionists at all, some such legislation as this is absolutely necessary in the interests of the cotton spinner or weaver. Yet this would evoke opposition on the part of those whose livelihood had depended on selling such machinery to manufacturers in other countries.

To pursue these parallels further were easy. Sufficient, however, has probably been said to show with what celerity any man could devise a system of protection to suit his own activities. The only drawback would be the difficulty illustrated by the saying, that one man's meat is another man's poison.

The absence of a policy which is anything but shallow and immediate in its aims has led the present writer to consider what might be the logical ideas of one who took for his motto, "Protection in Excelsis," and would accept nothing which fell short of this. An idealist in Protection ought surely to put in the forefront of his programme the abolition of imports of anything which competes with any industry—potential or established—but would also urge the prohibition

of exports of anything which could be used by any competing manufacturing country, either for supplying local needs, or for supplying goods to compete with ours in the neutral markets from which they and we alike seek food or raw material or luxuries.

In the eyes of the idealist of our fancy, who welcomes export taxes on coal as limiting the furnishing of the sinews of industrial warfare to our foes, the man who sells a loom to a German, a file to a Frenchman, a hammer to a Russian, or a lathe to a Spaniard, is as dangerous an enemy to the State as the man who would have sold field guns to the Boers, Maxim guns to the Mad Mullah, or battleships to the Dalai Llama. Every machine or piece of apparatus which can be used in any manufacturing process which is exported is absolutely giving an industrial weapon to our enemies. The man who sells a steamer to a Norwegian is as dangerous to the Empire as a man who votes for Free Trade. Looking abroad, what would such an idealist see to grieve him? He would see the German competing with his countrymen for raw material, such as wool exported from British Colonies. He would find that this was conveyed in ships burning British coal, flaunting sometimes the British, sometimes the German flag. In some Continental countries it is conveyed from the wharf to the factory in trains drawn by British built locomotives. It is woven in the factory by machines made in England, and the people of the country importing raw material clothe themselves in the cloth it furnishes rather than in the Bradford product. Turning to a British Colony—to the Dominion of Canada—the incorruptible, unflinching Protectionist would see Canadian ore exchanged against raw cotton, and at Niagara he would find American machinery being used to generate electricity from the power going over the Canadian Falls, part of this power being used in factories making various articles which the Mother-Country could produce, while the balance of it was being used by manufacturers in the United States.

The policy of the "sea-green incorruptible" of Protection, did such a gentleman exist, would be to prohibit the sale of any productive machinery to any foreign country. The importation of anything in a manufactured stage would be interdicted. Until our own supplies of iron ore were really exhausted no iron or steel should be imported, and then only in the form of pig-iron.

As for the Colonies, Downing Street cannot to-day close their factories as was done in the middle of the eighteenth century to the New England foundries in the interests of the even then threatened British iron-master. In the interests of the Empire, the Colonies should, however (*a*) cease to export any raw material to any foreign country or other colony; (*b*) cease to import anything from any place except from the United Kingdom, and then only in British ships; (*c*) impose an excise *ad valorem* duty of 25 per cent. on all goods manufactured in existing factories, the revenue from which would be allocated to such vital questions of Imperial defence as the periodic alteration of the pattern of the army headgear; and (*d*) refrain from erecting any further factories except under the licence of the Tariff Commission.

In extreme cases the Tariff Commission or Commercial Inquisition as it might then be re-named, might license a lumber mill, say, in Manitoba, provided that no smaller sizes of timber were produced than 12 in. baulks. For the preparation of doors or window frames, or match-boarding or floor boards, these baulks must be dealt with in Merionethshire. By these and other means the unemployed problem would be solved and work found for them in making new army caps or pearl buttons, which would educate their artistic perceptions, and be good for Birmingham and Dewsbury trades.

From the point of view of Imperial defence and offence, foreign policy could be easily outlined. It would be first necessary to evolve an efficient War Office, and generals of the type of Napoleon, von Moltke, Alexander the Great, and Julius Cæsar. Each war being then waged successfully, the tribute exacted would not be along the older lines of monetary payments such as Bismarck obtained from France, or the loot of art treasures, such as Napoleon sent to Paris in the days of the Directory, nor in the dismantling of fortresses, but would consist in the removal of all manufacturing implements. The silk weavers of Lyons would be induced to transfer their energies to the tending of silkworms in the interests of Spitalfields and Taunton, while the tool-makers of Berlin might be persuaded to return to the sandy soil on which their forebears eked out a sparse agricultural existence. Surplus subjugated populations for whom there was no hewing of wood or drawing of water available, might be recruited for legions on the familiar Roman lines; the Teuton might police the Slav, the Slav dragoon, the Latin, and the Latin could garrison the Mongol—all their officers being British or Colonial, of the Sandhurst brand.

I do not anticipate that the conception of Protection which I have presented will be accepted and acclaimed as the logical ideal of the movement. I may be told that my deductions are merely a *reductio ad absurdum*. But if protection is to be anything else than a temporary salving of the sores of those who announce their grievances the most plausibly, or a succouring and establishing of a few monopolist manufacturers who would benefit to the hurt of the many of their fellow countrymen, I must submit that my conception of "Protection in Excelsis" is not illogical, and is consistent in the protectionist sense. It is, however, opposed to all humanitarian or economic laws, which forces make for progress, for peace, for goodwill and prosperity.

CAMBUSLANG ELECTRICITY AND DESTRUCTOR WORKS.

By A. J. ABRAHAM, A.M.I.E.E., Resident Engineer.

The Lanark County Council is the first County Council to put up an electricity undertaking, so that in this way the combined electricity and destructor works at Cambuslang are unique. The destructor was started to work on June 5th, and the electricity supply on September 13th last.

The electricity works contain two Howden-Parker direct-coupled sets each of 55 KW., together with two Parker compound wound balancers. The switchboard is by the Edison and Swan Co., and consists of three polished slate panels with the necessary switches and instruments. The mains are all of Messrs. Glover's make. The feeders consist of two triple-concentric cables, each of ·2 sq. in. × 1 sq. in. × 2 sq. in. section. They are paper and diatrine insulated, and laid solid on the Howard system. The distributors are three-core, paper and diatrine insulated, lead-covered and armoured cables, and are laid direct in the ground. The street lighting and service cables are also armoured and laid direct. There are no underground boxes, but six feeder and fuse pillars. At these pillars the network is fused, and the street lights are switched on and off. These pillars are all connected together by a triple-concentric ring cable, ·1 sq. in. × ·05 sq. in. × ·1 sq. in. The sole object of this cable is to connect the feeding points together, and keep the pressure at the pillars even. The system is a three-wire direct-current one, supplying consumers at 250 and 500 volts. The street lighting consists of 20 8-ampere Brockie-Pell lamps, and 420 16-C.P. incandescent lights. There are at present 2,346 (equivalent) 8-C.P. lamps connected to the mains, and the maximum load observed up to the present is 51 KW. Several consumers, however, have yet to be connected up.

The destructor is of Messrs. Meldrum Bros.' Simplex front-feed type. There are three cells with a grate area of 75 sq. ft. The destructor is worked in conjunction with a Lancashire boiler 30 ft. × 8 ft., with 986 sq. ft. of heating surface. This boiler can evaporate 6,000 lb. of water per hour, and is by Messrs. Penman & Co., Glasgow. It is worked at a pressure of 200 lb. per sq. in., which is reduced to 120 lb. for the main engines. As a stand-by, a coal-fired boiler 24 ft. × 6½ ft., of the same type and make as the above, has been installed. These boilers are fed by a Worthington pump through a feed heater, and each boiler is fitted with an injector. Steam blowers inject air to the cells. This air is heated to 350° F. by means of a regenerator.

Messrs. Meldrum Bros. guaranteed the following results from this destructor:—

1. Absolute immunity from nuisance in the process of cremating refuse.

2. A consumption of 30 cwt. of refuse per hour on the grates.

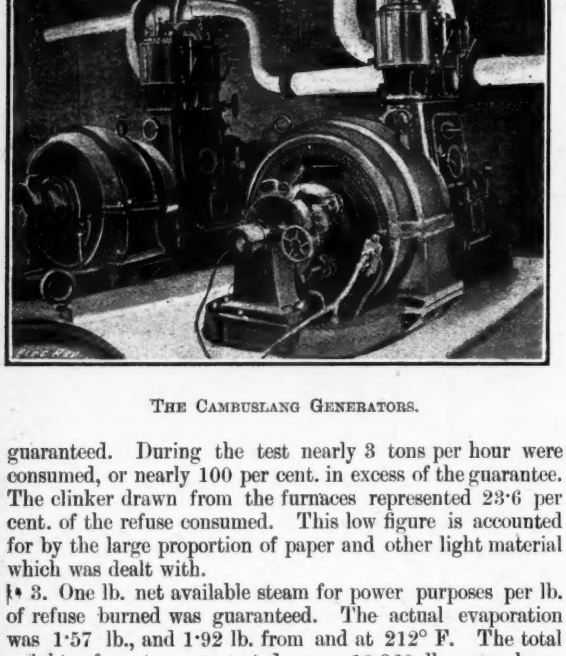
3. One lb. net available steam for power purposes per lb. of average household refuse consumed, after deducting the power required for forced draught.

4. An average combustion chamber temperature of 1,750° F.

On Thursday, October 26th, after the destructor had been working for nearly five months, a test was carried out for the purpose of meeting the above guarantees.

With regard to the first guarantee, I need only mention that the proportion of carbon dioxide in the gases of combustion reached an average of 16·31 per cent., denoting practically perfect combustion.

2. The total weight of refuse delivered was 17 tons 1 cwt. Tins, &c., weighed 2 qrs., leaving the net quantity consumed in cells, as 17 tons 0 cwt. 2 qrs., or 38,136 lb. The test commenced at 10.50 a.m., and the hopper was perfectly cleared at 4.20 p.m., and the last fire burned off by 4.40 p.m. A consumption of 30 cwt. per hour was



The Cambuslang Generators.

guaranteed. During the test nearly 3 tons per hour were consumed, or nearly 100 per cent. in excess of the guarantee. The clinker drawn from the furnaces represented 23·6 per cent. of the refuse consumed. This low figure is accounted for by the large proportion of paper and other light material which was dealt with.

3. One lb. net available steam for power purposes per lb. of refuse burned was guaranteed. The actual evaporation was 1·57 lb., and 1·92 lb. from and at 212° F. The total weight of water evaporated was 10,260 lb. per hour. Allowing 15 per cent. of the steam absorbed for forced draught and driving the pump, this leaves a substantial amount over the guarantee. The generating sets were far too small to utilise the whole of the steam generated. In consequence, nearly 60 per cent. of the steam generated during the test was blown into the atmosphere, a pipe being connected to the main for this purpose, which was going at full bore throughout the test. Some results are as follows :—

Units generated throughout the test	= 545.
Water used by engines for above work	= 4,000 lb. per hour.
Water blown to atmosphere	= 6,000 lb. per hour.

Had the generating plant been large enough during the test, 1,650 units could easily have been generated, this being at the rate of 97 units per ton of refuse—a very remarkable result when it is borne in mind that the feed water was perfectly cold. During the test, roughly speaking, 38,190 lb. of refuse did the work of 9,420 lb. single nuts.

4. An average combustion chamber temperature of 1,750° F. was guaranteed. The average temperature during the test—Watkin's patent heat recorders being used—was 2,500° F. The highest temperature taken was 3,000° F.

It is only fair to the makers to mention that the brickwork at the end of the test was in an incandescent state, and that the heat stored up in the furnace, combustion chamber and boiler setting was sufficient to keep the boiler blowing off repeatedly during the night. This evaporation was not counted (as it should have been) in the test, and, taking it into consideration, there can be no doubt that the evaporation from and at 212° F. during the test was over 2 lb. per lb. of refuse consumed.

ZINC AND ALUMINIUM FUSES.

By ALFRED SCHWARTZ and W. H. N. JAMES.

(*Concluded from Vol.* 57, *page* 794.)

Extending the recent investigation of zinc fuses to those composed of strip aluminium, a series of experiments was made with the fuse in a horizontal position with the axis of breadth parallel to the ground. On plotting fusing current and breadth for a constant thickness a straight line was obtained, and the law connecting these two quantities is of the character $c \propto (b + b_1)$; c = normal fusing current, b = breadth, b_1 = a constant.

On plotting fusing current and thickness for a constant breadth a curve is obtained, which approximates to a straight line with a slight tendency to become concave towards the

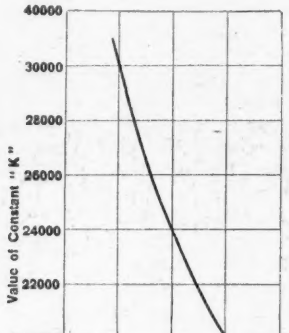


Fig. 1.

axis of thickness ; on drawing the mean straight line, however, the deviation of the extreme points will be found not to be large, and consequently we may take it that :—$c \propto (t + t_1)$, where t = thickness, and t_1 = a constant.

On experimenting with strip of various lengths and in different positions it was found possible to assume b_1 and t_1 constant for all cases ; consequently for aluminium strip—

$$c = k\,(b + b_1)\,(t + t_1).$$

c = normal fusing current ; b_1 = ·035 in inch measure = ·09 in cm. measure ; t_1 = ·0024 in inch measure = ·006 in cm. measure ; k = a constant.

This law holds between the following limits :—Breadth ·15 to ·8 in. (probably more) ; thickness ·003 to ·035 in. ; current per strip 25 to 600 amperes.

The value of the constant k depends upon the position and environment of the strip and its length between terminals, and also on the mass and character of the terminals used. The curve in fig. 1 gives the connection between the value of the constant k in inch measure (k in inch measure = k in cm. measure × 6·45) and the clear length of the fuse between terminals, with the fuse horizontal, the axis of breadth parallel to the ground, and terminals weighing 870 grammes each.

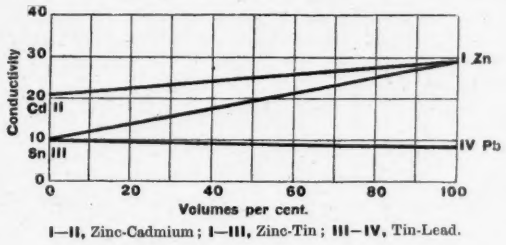
If the strip is placed horizontally but with its axis of breadth vertical, the fusing current will be higher than that indicated by the above law, due to the greater facility for cooling due to the edgewise position. The exact amount of this increase is difficult to ascertain, as it depends upon the breadth and thickness of the strip employed ; as an average value we may take the increase in the fusing current to be about 6 per cent.

If the axis of length of the strip is vertical and that of breadth horizontal, the fusing current is approximately the

same as when horizontal and edgewise, and thus is about 6 per cent. higher than with the strip horizontal and broadways on; in this respect aluminium differs from copper and zinc, for which the reverse holds good.

Aluminium attains a dull red heat just before fusion, and a strip which will carry two or three hundred amperes will, if blown on a low pressure circuit of 10 or 20 volts, throw off burning globules of metal to a distance of 2 or 3 ft.

An examination of the fuse after rupture discloses traces of a thin oxide film, but, with the exception of strip of small dimensions, this does not seem to have a prejudicial effect as regards the constancy of the fusing current. The short-circuit tests on aluminium strip were carried out on a 100-KW. generator with about 12 yards of cable of 1 sq. in. cross-sectional area in circuit. Strip with a normal fusing



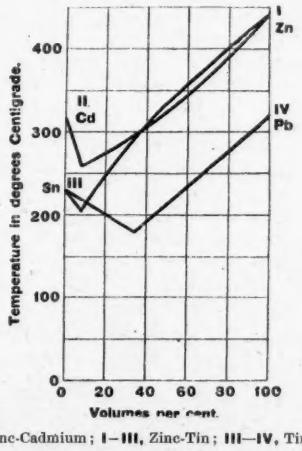
I—II, Zinc-Cadmium; I—III, Zinc-Tin; III—IV, Tin-Lead.

Fig. 2.

current of 100 amperes, when short-circuited, produced heavy fumes, and threw off numerous burning globules of metal to a distance of 15 or 20 ft.

With large fuses in which the breadth has been cut down for a couple of inches at the centre, the portion disrupted is almost entirely limited to this length, but the cutting down has to be carried to a much greater extent than with zinc. This is due probably to the much higher temperature attained by aluminium before fusion, and to the smaller volume of metal required for a given service.

Unfortunately, aluminium, zinc and cadmium are highly electro-positive to copper or brass, and in the presence of moisture this contact difference of potential is likely to give rise to corrosion of the contacts, with consequent increase of contact resistance and impairment of the fuse. There are, no doubt, situations in which these metals may be employed with advantage, but for damp situations such as network boxes and section pillars, they require careful inspection and attention. Aluminium is particularly difficult to deal with in this respect, as, although in normal salt solution or normal solution of sulphuric acid it is not so electro-positive to



I—II, Zinc-Cadmium; I—III, Zinc-Tin; III—IV, Tin-Lead.

Fig. 3.

copper as zinc is, yet unlike the latter it cannot be soldered to contact pieces or electro-plated. A good plan to adopt to overcome this difficulty would appear to be to coat the contact clips of the fuse blocks with tin, and so reduce the contact difference of potential between the fuse strip and the clips. Prof. W. W. Haldane Gee has been kind enough to determine a number of these contact differences of potential, and his results are embodied in the following table :—

Average Electromotive Forces in Volts Against Sheet Aluminium at 15° C. of Commercial Samples of Metals.

—	Normal solution of common salt.	Electrolyte normal solution of sulphuric acid.	Normal solution of caustic soda.
Copper	−0·54	−0·49	−1·23
Zinc ...	+0·31	+0·47	−0·29
Tin ...	−0·35	+0·08	−0·44
Iron ...	−0·33	−0·11	−0·90
Nickel ...	−0·50	−0·35	−0·94
Carbon ...	−0·80	−0·63	−1·15
Brass ...	−0·43	−0·50	−1·18
Silver ...	−0·57	−0·47	−1·16
Cadmium	+0·032	+0·41	−0·57

It may not be without interest at this juncture to contrast the conductivity of various alloys of the metals under consideration, and also their melting points. Fig. 2 shows graphically the results obtained by Mathiessen* for the conductivity of alloys of cadmium-zinc, tin-zinc and tin-lead of varying proportions by volume. Fig. 3 shows the melting points of these alloys in degrees Centigrade plotted from Gautier's† determinations. Some of the zinc-aluminium alloys are already in use for fuses.

The above experiments were carried out in the electrical laboratories of the Municipal School of Technology, Manchester, and the writers wish to express their indebtedness to Mr. H. Gill for assistance in the experimental work.

ELECTRIC LIFTS.

By PERCY GOOD, A.M.I.E.E.

The claims made from time to time on behalf of hydraulic lifts deserve some attention from electric lift makers. A pamphlet recently issued by the London Hydraulic Power Co. states that if everything is taken into consideration, it will be found that the hydraulic lift is the safest and cheapest to use. This statement is unsupported by any evidence.

The question of safety is of the utmost importance, and the claims made under this heading require examination. In the pamphlet referred to above, the elements of danger in an electric lift are given as follows :—

1. The use of a mechanical or electro-magnetic brake to absorb momentum.
2. The use of a balance weight heavier than the cage.
3. The great danger of overwinding.
4. The numerous points connected with the control which may cause accidents.

The gear in use between the electric motor and the winding drum is almost always self-supporting, so that if the brake does not operate there is no element of danger introduced.

The "overbalancing" of the cage does not introduce greater possibilities of danger unless it is admitted that the larger the lift the greater the danger or the remote possibility of the counterweight falling.

The possibilities of overwinding can always be removed when the old-fashioned winding gear is used, by arranging a switch at the ends of the winding drum. With a "V" drive there is no danger even if the gear does continue to run.

The pamphlet also states that : "At the same load factor there is an economy of production in favour of hydraulic power. . . . . " "When the machinery is properly proportioned, the economy of hydraulic lifts at full load is so great that at all loads less hydraulic than electric power is used to do the same work. . . . . " "The employment of worm-gearing at a self-sustaining angle (inherent in the nature of the machinery employed) involves a great loss of efficiency."

It should be noticed that the important question of the cost of working is not very definitely stated.

When considering the running cost of a lift, it is difficult to decide on the conditions under which the tests shall be carried out to represent fairly actual practice, but it is quite

* *Phil. Trans.* Roy. Soc., 1860.
† *Bull. de la Soc. d'Enc.*, Vol. 1, 1896.

easy to carry out tests under various conditions and decide from those which are the fairest to use for comparison.

The following are the results of tests carried out on four automatic push-button electric lifts. In Table I. the particulars of the lifts are given :—

Table I.—J. Richmond & Co., Makers.

Reference number.	Weight of cage, cwt.	Weight of full load, cwt.	Weight of counter-balance.	Length of travel, feet.	Number of floors.
1	9	10	14	67·6	7
2	5	3	6½	35·4	4
3	10	7½	13½	55	5
4	12	10	15	76·5	7

In Table II the results of a series of tests on these lifts are set out. The average current was obtained by taking readings, at short intervals, of the current on a dead-beat ammeter.

Table II.

Reference number.	Weight in cage, cwt.	Time of complete up journeys, minutes.	Average speed in feet per minute.	Average current up journey, amperes.	Average pressure in volts.	Number of up journeys for 1d.; energy at 2½d. per B.T.U.
1	10	0·62	109	8·2	543	8
2	3	0·32	109	12·3	203	27
3	7½	0·80	69	9·0	498	7
4	10	0·70	105	21·4	210	8

As it was not convenient to separate the motors and test their efficiencies, certain values have been assumed, and the efficiencies of the lifts and gears calculated. In Table III. the assumed efficiencies and the makers' rating for the motors are given.

Table III.

Lift number.	H.P. supplied to motor.	Assumed efficiency of motor.	Calculated H.P. required to raise the loaded cage at normal speed.	Efficiency of gear and lift mechanism, per cent.	Rated H.P. of the motor.
1	5·97	70	1·85	44	8
2	3·33	60	0·56	28	2
3	5·32	65	0·88	25	5½
4	6·02	70	2·5	59	8

It is claimed that the tests on complete journeys do not represent ordinary working conditions, as the starting and stopping in the case of the electric lift add considerably to the power required. In order to ascertain the value of this extra, the consumption of energy on complete up and down journeys was measured—first, when the lift was only started and stopped at the top and bottom ; and secondly, when it was stopped and started on each floor. This test was carried out on lift No. 1, and the increase was found to be 30 per cent. As a general rule, the lift will not be used for journeys from one floor to the next, but the average will be much nearer three floors, so that, if an increase of 15 per cent. be allowed, there can be little doubt that it is liberal.

The energy consumptions of lift No. 1 with different loads in the cage are shown in Table IV.

Table IV.

Load in cage in cwt.	Average current at 543 volts pressure.		Journeys for 1d. at 2½d. per B.T.U.	
	Up.	Down.	Up.	Down.
0	3·4	8·9	20	7
2½	3·7	7·1	19	10
5	4·4	5·3	16	13
7½	5·9	3·4	11	21
10	8·2	2·9	8	26

The difference in the efficiencies of lifts No. 1 and No. 4 is probably due to the use of steel guides in the latter case and wooden ones in the former.

To compare the cost of working of an electric lift and a hydraulic lift, it is necessary to make some approximations. A lift similar in size to No. 1 in a house with a number of offices will be very busy if it makes 150 journeys per day. The consumption of water with a lift of this size cannot be less than 8 gallons per complete journey.

If we assume that the average load is one-half full load, and the average height one-half the total height, we obtain the following figures :—

150 journeys at 4 gallons per journey = 600 gallons per day.
600 × 5½ × 12 = 39,600 gallons per quarter.
Cost, as taken from scale supplied by the London Hydraulic Power Co., = £8 3s. 6d.
150 journeys, taking 0·0274 B.T.U. per journey = 4·1 B.T.U.
Add 15 per cent. for stoppages = 4·7 B.T.U.
4·7 × 5½ × 12 = 310 units per quarter.
Cost, at 2½d. per unit, = £3 4s. 7d.

This represents an annual saving of £19 15s. 8d. If we work it out on the assumption that full load is carried every time, we obtain results from data which give the hydraulic lift every advantage, and we find that the quarterly cost of the electrical energy is £3 13s. 9d., or an annual saving of £17 19s. 4d.

The questions of first cost and maintenance have been omitted, as it is easy to obtain for any particular site estimates of first cost and cost of maintenance for both forms of lift.

From the figures given above it does not appear that the claims made on behalf of the Hydraulic Power Co. in the pamphlet to which attention has been called can be substantiated.

ROUGH NOTES ON ELECTRIC DRIVING.

By FRANK BROADBENT, M.I.E.E.

I cannot more appropriately meet the editorial request for a short New Year article on some topic of general interest than by drawing upon my experience in the matter of electric driving ; believing, as I do, that the year 1906 will be a record year in this branch of the electrical industry.

Notes based upon personal experiences are necessarily somewhat egotistical ; so this characteristic will be understood and pardoned. The results of the discussions on the power Bills before Parliament last year, whilst, perhaps, not entirely satisfactory to the promoters, have indirectly benefited the industry both by stimulating existing supply authorities to specially cater for motor work, and by educating the general public up to the fact that a cheap supply of electricity for power purposes was immediately possible. I refer more particularly to the conditions in and around London.

The rapid spread of electrical driving is one of the most satisfactory features of the last few years so far as the electrical industry is concerned. It has entirely changed the character of the older established works, the manufacture of dynamos for private installations having largely given place to motor manufacture, and new works devoted almost entirely to motor work have arisen all over the country. From the manufacturers' point of view, the unsatisfactory part of all this is that keen competition has cut prices down almost to the point of unprofitableness.

The question that most frequently arises when one is called in to advise upon an electrical driving proposal is, "How does the cost compare with gas engine driving ?" It is very difficult to give comparative figures of installations working under identical conditions, because, by the time a gas-engine driven system has been superseded by electrical driving the conditions have generally altered. More machines have been added, or old machines have been replaced by new ; the running hours are not the same, and so on. The outstanding fact, however, remains that no one having really given electrical driving a fair trial ever reverts to the old system.

Although the collateral advantages of driving by electricity—such advantages as steadiness, absence of dirt and shadows from shafting and belting, increased output, better

speed control, &c.—are pretty generally recognised, a works owner frequently expects all these things to be thrown in for nothing, and compares only the cost of electricity with the cost of gas or coal, often enough taking no account of the savings due to diminished costs of oil, wages, repairs to shafting and belts, and the like.

As comparative figures from actual installations are more convincing than calculated data from assumed conditions, the following may be of interest. A printing works installation was electrically equipped on the individual drive system, that is, little or no shafting was used. Electricity was generated on the spot by a modern high-class gas engine of 40 B.H.P. The cost of gas alone, at 2s. 10d. per 1,000 cb. ft., was slightly over 1¼d. per unit generated. The cost of oil and small stores and repairs to main belts brought up the running costs to approximately 1½d. per unit, neglecting labour. Had this works been driven through shafting and belting in the old way a larger engine would have been needed, giving from 50 to 60 B.H.P., and the cost of gas would, of course, have been more. Electrical energy is now taken from the public supply mains at 1½d. a unit, effecting a considerable saving in labour.

Here, then, is a case of economy effected by using town's electricity for motor driving, instead of town's gas for electrical generation, and much greater economy than by using town's gas for driving by belting and shafting.

The question is sometimes asked in this way: "How many units of electricity are equal to 1,000 cb. ft. of gas?" Here, again, the equality of conditions comes in. I had recently occasion to make a comparative test which serves as a useful guide in this direction. A printing works driven in the old way by gas engines, was also equipped with motors, which were used for overtime work. The motors were arranged to drive individual machines, so that it was only necessary to run those machines which were needed after the regular hours.

By running a full week on gas alone, and a similar period on electricity alone, during which periods the nature and amount of work turned out was as nearly as possible the same, I found that 41½ cb. ft. of gas was the equivalent of 1 unit, or, in other words, that 24 units compared with 1,000 cb. ft. of gas. The conditions were favourable to the gas engine, as the mechanical losses in transmission were below the average for works of this nature; and, on the other hand, the motors were handicapped by having in many cases to drive the overhead cone shafts.

Under the above conditions, then, in which gas had considerable advantage, electricity at 1d. a unit equals gas at 2s. per 1,000 cb. ft. Under the conditions usually met with, 1,000 cb. ft. of gas would more nearly correspond with 18 to 20 than 25 units; electricity at 1d. a unit being, then, the equivalent of gas at 1s. 6d. to 1s. 8d. per thousand. These figures have not, of course, a general application; they refer to works, like printing works, having a large number of small machines which work intermittently.

A very important advantage which results from electrically driving printing machines is the increased output consequent upon the steady driving and the speed control. This increase may easily be as much as 25 per cent., and in some cases more. It is argued that in printing offices doing a regular class of work, say magazine work, the machines are always kept on the top speed, so that the increased output advantage cannot apply. But it does. Quite recently a couple of machines in such a works were driven by motors as an experiment. The speed was set to 1,700 impressions an hour, the same as when driven from the gas engine. This was, in fact, the maximum safe speed for the machines. After the first day's run the overseer told me—and he was not in love with electrical driving—that the machines had turned out 1,000 copies each more than usual. This was an increase of 10 per cent., yet the speed was apparently the same. The explanation is the steady rate of turning—a steadiness which no other method of driving can give. There is a double advantage in this steady drive; not only is the output increased at the same nominal speed, but higher speeds are possible, as a "layer-on" can keep a better "register," that is, he can "lay on" more accurately at a fast speed which is uniform, than he can at a lower speed which is variable.

Much of the economy of domestic electric lighting is due to the fact that it can be so easily switched on and off as required. The same holds good for electric power. On a steady load a single motor can only beat a gas engine when the cost of energy is exceptionally low. But a steady load is also exceptional, and the greater the fluctuation in the load curve, the better will the electric motor show up as compared with the gas engine. I have figures before me of a printing works in which a single motor replaced a gas engine, resulting in a saving of over 15 per cent. on consumption alone; the cost of gas being 2s. 8d. per 1,000 cb. ft., and electricity 1·8d. per unit. When account is taken of the saving of labour, oil, &c., the saving was as much as 25 per cent.

Mechanical driving systems are generally so inefficient that it does not need the exercise of much engineering ability to effect an economy by electric driving. This, perhaps, explains why one comes across so many badly-designed electric motor installations.

It is a fairly easy matter to put down a few motors and belt them up to line shafts; but insofar as an electric installation falls short of the highest possible economy, to that extent it is a failure. The best results are only obtainable by a careful study of the individual requirements of each machine, which should then be driven in such a way that the sum of the interest and depreciation charges on its equipment, *plus* the cost of energy and up-keep, are a minimum.

Under a competitive system, in which each tenderer puts forward his own scheme of driving, the tendency is, of course, to sacrifice economy of operation to initial cost, as initial cost is the one item the purchaser understands.

This not only makes for inefficiency, but generally means a lack of uniformity in the motor sizes. In a scheme of about 25 motors, which a little while ago came under my notice, there were about 20 different motor windings. Think what this means in the matter of spare gear and interchangeability. By a little re-arrangement and very little modification in the price, the number of sizes was reduced to six.

Again, in two separate motor installations aggregating about 70 and 100 H.P. respectively—installations which probably showed considerable economy over the mechanical systems they had replaced—it has been possible by re-arranging or re-designing the systems to reduce the consumption of electrical energy in each case by an amount equal to approximately £100 a year, a saving of from 20 to 25 per cent.

The weak point of an electric motor installation is the starting switchgear, more particularly when the system is individual driving. It is the unfortunate fact that there is not a starter on the market sold at a moderate price, which will stand six months' of printing press work without very careful nursing. A motor geared or belted direct to a printing press, must be started and stopped repeatedly when "making ready," and the starter must be capable of making and breaking the circuit intermittently with scarcely a second's interval.

As the circuit is broken when the motor is crawling round, there is practically no back E.M.F., and the switch must break the full voltage, which, under modern conditions of supply, is from 400 to 500 volts. This is pretty rough work for a 2 to 5-H.P. switch, but these are the conditions to be fulfilled, and a switch must be evolved that will fulfil them satisfactorily, and not cost an impossible price.

The motor, too, on a printing press has a lot to put up with. The starter is pushed over in, perhaps, 3 seconds or so, and the motor takes anything up to five times its full load current.

The fuses are, of course, gradually strengthened until they refuse to blow, and the overload release, if there is one, is tied up.

True, there is a notice on the front of the starter reading "Start slowly," but it is an impossible operation under some circumstances. How can a "layer-on" take 15 seconds to move a starter handle over when his machine, printing, say, a quad-royal sheet, is speeded up to 1,600 impressions an hour—not a particularly fast speed? He sets one sheet under the grippers, and begins to move his starting handle. In a few seconds he wants his hand back on the feeder board,

because a sheet of this size is a two-handed job—and over goes the starter with a jerk.

It is futile to say: "Start slowly!" and to ask in effect that the conditions prevailing in the printing office should be modified to suit the requirements of a starting switch. No! Starters for this class of work must eventually be worked like, and stand the same rough treatment as, the brake lever, whilst being so constructed as to protect the motor from injury.

TRAIN LIGHTING BY ELECTRICITY.

A remarkable feat has just been accomplished on the Great Western Railway. Our readers will remember that in our issues of March 17th and 24th last we described the Leitner-Lucas system of electrically lighting trains, in which a self-regulating dynamo is used to charge a battery of accumulators, the whole equipment of a coach being self-contained and automatic. Since that date further improvements have been effected in the dynamo, which now has a single armature and commutator, and yet, by means of a special arrangement employing a pair of auxiliary brushes, is enabled to give a practically constant current. A number of equipments of the latter description, as well as of the former type, have been in use on the Great Western Railway (and other railways) for a considerable time, with successful results. It is claimed for this system that the minimum of attention is required to keep it in working order—that is, that inspection of the battery, commutator, &c., say, once a week, topping up the cells, and replacing brushes when necessary, is all that is required. It is, of course, very easy to make claims of this kind; but Mr. H. Leitner, managing director of Accumulator Industries, Ltd., the owners of the system, was so confident of the capabilities of his apparatus, that he agreed to put it to a crucial test, which took the shape of sealing up the battery, dynamo and other automatic apparatus for a period of no less than three months.

With the approval of the railway company, it was decided to carry out the test on the Cornish Riviera express between London and Penzance. Three coaches were chosen, the equipments thereon were sealed up jointly by the railway company and Accumulator Industries, Ltd., in such a way that cleaning, oiling, topping-up and all other adjustments were rendered impossible without first breaking the seals. The installation in one of the coaches (No. 1640) comprised 12 10-c.p. osmium lamps in three first-class compartments, 10 12-c.p. carbon lamps in five third-class compartments, and eight 8-c.p. carbon lamps, making in all 304 c.p. in a composite coach. The osmium lamps consumed from 1·7 to 2 watts per candle, the carbon lamps 3½ watts per candle. The battery, giving 23 volts, had a capacity of 180 ampere-hours, and the dynamo was rated at 2½ kw. The other two coaches were similarly equipped, with differences only in detail.

The three months' trial came to an end at Penzance, on Saturday last, with gratifying success; and on Monday evening we were present at Paddington Station when the train arrived. We had the pleasure of inspecting the lighting—which was excellent—and the equipments, which still bore the unbroken seals. Normal voltage was shown by the voltmeter carried on board, and also by the lamps, which gave a brilliant soft light, in contrast with the hard harshness of incandescent gas. There was no sign of any derangement of the apparatus whatever—so far as could be seen, it was ready for another three months' run. And we were assured that the equipments had remained sealed up, without receiving, therefore, a particle of attention throughout the whole period. It will be observed that the 12 weeks in question were the most trying period of the year, when any failure of the lighting whatever must have led to complaints and necessitated the overhauling of the equipment.

During that time the composite coach above referred to had travelled 25,200 miles, equivalent to a journey round the earth, with a fair margin to spare—to which must be added the return trip of 326 miles accomplished on Monday. A second coach (No. 3490) had also successfully accomplished the three-months' trial, but having missed four journeys through an accident in no way connected with the lighting, had covered about 24,000 miles. The third coach, which was started later than the others, ran 17,000 miles. All these coaches finished the trial with the lighting perfectly efficient and satisfactory. It should be mentioned that the three equipments are the property of the Railway Co., and had been running for some time before the commencement of the trial. The cost of the lighting of these three coaches during the trial has obviously been confined to the interest and depreciation on the capital outlay, and to the very small percentage of coal burnt in addition to that required to haul the train—the dynamo only gives 1·3 kw. even when running at full load, and its efficiency is from 70 to 78 per cent. Only three lamps were renewed, and in each case the failure was due, not to burning out, but to accidental breakage.

It will be admitted that this achievement is not only a triumph for the company, but also an excellent testimonial to the reliability of electrical plant under extremely arduous conditions; and we have pleasure in tendering our hearty congratulations to Mr. Leitner on its successful accomplishment.

Since writing the above we have been informed of the result of the inspection which followed the unsealing of the equipments. In addition to the representatives of Accumulator Industries, Ltd., G.W.R. officials from the Traffic Department at Paddington and the engineering works at Swindon were present.

We learn that the equipments were found in perfect condition, and the coaches were ordered to go immediately into service again, without any repairs or renewals. There was oil enough in the oil-wells for about another three months' run. The carbon brushes were evenly worn, and had nine months' wear in them, at the same rate: the commutators were in good condition. The batteries were fully charged, with the specific gravity about 1,220—their normal sp. gr. when charged being 1,205. They could have run four months longer at the same rate without topping-up. The automatic cut-out was also in perfect condition.

This remarkable result is, as we have said, a triumph for electricity, as well as for Mr. Leitner—who, by the way, is prepared to repeat the feat on any British railway—and we have great pleasure in placing it upon record.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

The Momentum Engine.

Open Letter.

19, Imperial Buildings,
Ludgate Circus, E.C.
December 29th, 1905.

The Editor of the Electric Review,
4, Ludgate Hill, E.C.

Dear Sir.

I am quite sure that you have crossed the line in the pretence that as a public duty, you exposed anything in the Momentum Engine. You won your action simply because we concluded to put no witnesses on the stand upon our side, your men never took an Indicator Card off the Momentum Engine, in fact we were awfully afraid they might do it, and they would have discovered that the indication of the four engines was less than the power delivered, besides half the power of the indication is never connected to the line shaft at all, and each independent engine has to do its work through its fly-wheel without reference to the next engine and its fly-wheel, but they had to swear that one fifth delivered 30 points of a hundred and furthermore swore that by mechanical construction, doubling the weights, the one fifth delivered 33 of a hundred four-fifths never connected to the line shaft, and the work done in the engine to make it perform that duty doubling the weights to be carried was contrary to the theory of energy, for had that theory been worth the paper it was written on, the first and second tests should have been 19 of a hundred points and 9 of a hundred points. It is a great pity that you make

the attack upon Professor Sherman, Member of the Institution of Continental Engineers. It looks purile, and of course, to describe the engine improperly is great nonsense, there are so many people who understand the engine, so that it makes your article quite ridiculous. It may be of interest however to you to know that Johnson & Phillip's Electric Motors, four of them pulled upon the great fly-wheels, as well as the four steam engines, the result being the indicated horse Power was LESS than the Electrical Horse Power delivered. With reference to your bus-bar business it is all nonsense, but as you say "Clearly if this be so, when the machine is driving a dyanmo, he needs only to substitute a set of motors for his engines and couple them to a dyanmo." This he has done with the four Johnson and Phillips Electric Motors, but if you place into the engine four Pole Differentially Geared Electric Motors, in place of the Johnson and Phillips ; Pole Motors United States Letters Patent Number 527,023, October 2nd, 1894, in which you double the B.H.P. of the motor without increasing the volts and amperes for driving, "then he can save all his coal and have a margin of power for electric light and other purposes" and in which he most cordially accepts the proposition. It may be interesting for you to know that a fund was exploited in the sixties for the establishment of false science, that the Keely Motor served the extraordinary purpose of holding out an idea—Here is a man with such an extraordinary invention that if true, *there is nothing to find out*, a bucket of cold water to run from New York to San Francisco. The author of this letter exposed the Keely Differential Hydraulic Pistons for the Franklin Institute of Philadelphia. Kelly then abandoned the water idea and picked up the etheric, pulsatic, harmonic chord of power, passed over a platinum silver wire, very difficult to obtain the wire, 40 H.P. for the pull of a note on a fiddle, *i.e.*, the fellow down in the cellar heard the sound and truned on the compressed air. But what did it mean, for we were looking into it from another standpoint, it meant simply this, that with both the bogus Kelly motor on one hand, and a bogus paid for theory of energy on the other hand, no man or set of men will command the money to use the capital for a scientific investigation in the laws of power, as it really is, desirable to fool the electrician into the idea that it is great electrical discovery is to be made and keep him off of the track that the key to universal Electric Light is spelled POWER ! ! !

I am well aware that my engine has been spitefully and maliciously fought by the secret-police-agents of hostile interests to prevent universally electric lighting.

Yours faithfully,

B. C. Pole,

p.p. G. C.

[If, after working through Mr. Pole's letter, which is printed *verbatim et literatim* as received by us, any of our readers can make out what he is driving at, we shall be greatly indebted to them for an English translation of the effort. Only one or two points are intelligible—to us, at any rate—and we shall comment on these alone.

Our case, in the action for libel, was based upon the apparatus exhibited by Mr. Pole at the Aquarium, in which the fly-wheels were driven by electro-motors, and, of course, no indicator cards could be taken. Had we carried out tests on the Alexandra Palace installation, "by order of the Court," as in the case of the Aquarium installation, we are absolutely certain that similar results would have been obtained, to the confusion of the Poleforcia fallacy.

Next, we note that the cat (or the mouse) is out of the bag as regards "Professor Sherman, Member of the Institution of Continental Engineers." "*Continental*" is good. This, we take it, is an Institution made in Shermany, and consists of one member. It looks, not "purile," as Mr. Pole says, but pure bunkum.—Eds. E.R.]

Electric Fires.

In houses, business premises, halls, churches, theatres, &c., where electric light has been installed, how many fires have taken place which can be traced to electricity as the cause? Out of all these fires, what percentage have taken place in buildings where the electric wires and cables have been run in tubes and also where wood casing has been employed? It would be interesting if you could give us statistics as to this either for London or some other city for the year 1905. We want to see from these whether the greater number of fires have taken place on installations where tubing has been employed to run the wires, or when wood casing has been employed.

R. C. A.

[Some interesting particulars of the kind asked for were given by Mr. W. W. Lackie in his I.E.E. paper, abstracted in our issue of February 17th, 1905. We should think that the fire insurance companies would be able to furnish the desired information.—Eds. E.R.]

"Brighton" Railway Contract.

Your number of December 22nd contains an article about the Brighton contract, and our firm's experience in the single-phase system in comparison with the experience of the same kind which can be shown by the Westinghouse Co.

Permit me to say that such statements are not to be considered as conclusive if they do not include all elements of importance. For instance, the mere number of lines does not decide the question on which side there is the greatest experience, but this decision is principally depending upon the conditions under which the single-phase system is working, and how many cars are in operation. The London-Brighton Co. required the multiple-unit system combined with the single-phase system, and to fulfil this peculiar condition for suburban traffic has been the object of our company's experiment for years. The Spindlersfeld line has from the beginning been equipped with this combined system, and has been worked for 2½ years under the surveillance and with the collaboration of the Prussian State Railway Department. That our experience has been successful may be inferred from the fact that the Prussian State has given our company the order for all the car equipments for the Hamburg suburban lines. The first of these equipments has already been tested on the Spindlersfeld line and proved to comply with all requirements in every way, as well electrically as in regard to the safety devices.

The Westinghouse Co., as far as I know, has hitherto not equipped any line with this combined system, and this may be the reason why the Brighton Co. preferred our offer.

Ph. Pforr.

Allgemeine Elektricitäts Ges., Berlin.
December 30th, 1905.

Regenerative Control.

There are amongst us some out-and-out believers in Raworth's (all shunt) system of regenerative control. I say Raworth's advisedly, as it has been in successful operation at several places; the Johnson-Lundell system (series and compound) would no doubt answer the same purpose, but it has not yet obtained a start.

Others admit that, theoretically regenerative control is perfect, but in practice it has grave defects, while certain contractors assail it because it is inimical to their interests as motor makers.

Would it not be possible for Mr. Raworth to come to some arrangement with the L.C.C. to pit one of his cars against those of the Council on one of its many routes? Should he prove successful, it seems to me that his claims could no longer be challenged.

It might serve, too, as an object lesson to the electrical engineer of the L.C.C. Why does not Mr. Raworth make a sporting offer?

O. N. Looker.

January 2nd, 1906.

A Novel Proposition.

I enclose herewith copies of letters sent by Mr. W. Bates, borough electrical engineer of Birkenhead, to some of the principal users of the current. The electrical contractors of Liverpool and Birkenhead consider this most unfair treat-

ment, and would like to have the opinion of contractors in other towns on this matter.

Akbar.

[copy.]

Birkenhead Corporation Electricity Supply.

Electrical Engineer's Office,
Craven Street, Birkenhead.
November 4th, 1905.

————, Birkenhead.

Dear Sirs,—It has doubtless come to your knowledge that within the last few years considerable strides have been made towards decreasing the cost of electric lighting by the adoption of lamps of higher efficiency than the ordinary type of electric incandescent or "Glow" lamp, which is generally in use.

The holders of the patent rights in this country of the "Nernst" lamp, which is certainly one of the most efficient of these new lamps, the A.E.G. English Manufacturing Co., of London, being themselves perfectly convinced of the saving which can be effected by the substitution of Nernst lamps for those which you have already in use in your establishment, and feeling that there is only one practical way of demonstrating to you that, inclusive of the extra maintenance cost, you will, if you adopt their lamps, effect a considerable reduction in the amount of your yearly bill for electrical energy, have asked me to lay before you, on their behalf, the following proposition:—

1. The company are prepared to send their expert to inspect your premises, and to advise you as to the method of altering your existing lighting arrangements so as to obtain the best effect from the new lights.

2. The company will prepare an actual comparison of the cost of your present lighting and the lighting which they would suggest, and will submit same to you for your consideration.

3. The company will furnish you with an estimate of the cost, for which they will undertake to carry out the alterations which they suggest.

4. In the event of your entrusting this work to them, they offer to give you a guarantee that, inclusive of all burner renewals, you will effect a saving of at least 20 per cent. in your electricity bill.

If you are prepared to give this matter further consideration, and would like the company's expert to call upon you and discuss the matter further, please be good enough to signify the same to me in writing so that I may acquaint the company of the fact.

To put the saving which ensues where a consumer adopts the rearrangement, as proposed by the A.E.G. Co., in a manner which you will easily understand, I have set forth hereunder particulars of a conversion which has recently been effected:—

Original Lighting with "Glow Lamps."

Number.	Fittings.	Candle-power on each fitting.	Total candle-power.	Watts consumed per hour.
3	5-light	80	240	900
1	1-light	16	16	60
8	1-light	16	128	480
8	1-light	16	128	480
2	3-light	48	96	360
			608	2,280

Total cost of lighting per hour: 11½d. for a light of 608 c.p.

Present Lighting by "Nernst" Electric Lamps.

Number.	Fittings.	Candle-power on each fitting.	Total candle-power.	Watts consumed per hour.
3	½ amp. Luna	125	375	360
1	"B" type	40	40	60
4	"B" type	40	160	240
4	"B" type	40	160	240
4	"B" type	40	160	240
			895	1,140

Total cost of lighting per hour: 5⅞d. for a light of 805 c.p.

In both cases, voltage 230 and price of current, 5d. per unit.

It will be seen on comparing the two tables, that by the conversion the consumer obtains 287 more candle-power, or an increase of over 46 per cent., in his lighting, while his bill for current consumed is reduced by 5⅞d., or exactly 50 per cent.

In conclusion, I may say that if, prior to making up your mind in regard to asking the company's expert to call and see you, you wish for further information from me in the matter, I shall be very pleased to furnish you with the same if it is in my power.

I am, my dear Sirs, yours faithfully,

(Signed) Wm. Bates.

Borough Electrical Engineer.

[copy.]

Birkenhead Corporation Electricity Supply,
Electrical Engineer's Office,
Craven Street, Birkenhead.
November 11th, 1905.

————, Birkenhead.

Electric Lighting.

My Dear Sirs,—On the 4th inst. I wrote conveying to you particulars of an offer made by the A.E.G. Manufacturing Co., of London, whereby they guaranteed that if you used their electric lamps you would effect a saving of at least 20 per cent. in your electricity bill, and I asked you to let me know in writing whether you were prepared to discuss the question with the company's expert or not.

As the company are only prepared to make this offer to a very limited number of the Birkenhead Corporation's consumers, and as I wish to send them the list of consumers who wish to see their expert as quickly as possible, I must ask you to give me your answer by Saturday, the 18th inst., at latest.

If I do not hear from you by that date, I shall conclude that you do not wish to consider the matter, and that I am at liberty to place the company's proposition before some one else in your stead.

Yours faithfully,

(Signed) William Bates.

Foreign Competition.

There appears to be something wrong with the foreign arc lamp carbon market at present, as I expect many buyers have found out to their cost. English firms, instead of taking advantage of this to introduce and push their own carbons, are now selling at prices which, to the unfortunate customer, *look* very like extortion. In August I received these quotations for 1,000 pairs 15 mm. and 9 mm. carbons from two firms—a well-known English and German firm respectively:—

German firm: £2 10s. (delivery in three weeks).
English firm: £2 10s. (delivery in one week).

The tender of the English firm was on this occasion accepted. In December, for 1,000 pairs of exactly the same carbons, the tenders were as follows:—

German firm: Unable to deliver for considerable time.
English firm: £4 15s. (delivery at once).

I have, however, been fortunate enough to obtain 1,000 pairs of the German carbons from the stock of a Glasgow firm for £2 17s., or I should have been compelled to pay £4 15s. to the English firm. Perhaps other readers have not been so fortunate.

This kind of thing looks like very bad business, and seems to point to the fact that foreign competition is an excellent thing. When foreign carbons are again thrown on the English market, I should say that the English firm mentioned above would suffer considerably on account of the way they are now tendering.

Carbon Dust.

What's Wrong?

Without entering into any general discussion on matters more or less political, may I offer a few remarks on your interesting editorial in last week's Review?

You say that, "for the sake of a tax on the small volume of the foreign manufactured imports, we must pay a tax on the huge volume of home manufacture."

But would it be possible, in the first place, for home prices to rise more than 4 per cent. or 5 per cent., even if a prohibitive tax were imposed? Home competition, as in the case of Admiralty contracts at the present time, would only allow an honest profit to the manufacturer.

Then, secondly, if the home price did rise by that amount, *who* is "paying a tax on the huge volume of home manufactures"? The customer is paying the manufacturer an honest price, which he ought to have been getting before—that is all.

Surely you, Sir, as an engineer, would not grudge the poor manufacturer another 3 or 4 per cent. on the present microscopic profits?

The enhanced price is not a loss to the country as far as the home manufactures go; while, if the worst happened, and the whole of the tax on such manufactured articles as were imported fell on the buyer, only the same amount would be contributed as now to necessary national expenditure—only in a more useful way.

No one, by the way, has suggested a tax on raw material. The whole object of Protection is to encourage an exchange of *our* manufactures for other people's raw materials.

This brings me to your statement that imports are "sent here in exchange for exports."

Assuming, for the sake of argument, that this is true on paper, surely there is something wrong with it in concrete fact.

The foreigner can send us whatever he can best sell—which is too often manufactured goods—but has it in his power, not only to force us to pay him in more or less unmanufactured material, but also to get plenty for his money. That is, the English manufacturer can only sell in Germany, say, what German tariffs permit him, and often, to sell at all, he has to cut his price.

In other words, the protected country always gets the *best of a bargain*, even though the paper values of the goods exchanged may balance.

This is not mere theory. I think most manufacturers could bear me out.

While most people realise the influence of foreign competition in displacing labour and lowering prices, few are as patriotic and enlightened as the directors of the L.B. and S.C. Railway, who so recently have prevented the loss to this country of the large amount of employment resulting from the electrification of their railway.

Is it unreasonable to suggest the adjustment of existing taxes so as to make it *worth while* to buy home manufactures? Most people would be patriotic and enlightened then.

While I cordially agree with many of your alternative proposals, they strike one as very inadequate means for putting right what is admittedly wrong.

G.

REVIEWS.

Experimental Researches on the Flow of Steam through Nozzles and Orifices. By A. Rateau. London: Constable & Co. 1905. Price 4s. 6d.

This is a small book which gives an account of the author's experiments on the flow of steam through nozzles, undertaken because of the importance that has come to be attached to the subject by reason of the development of the steam turbine.

The method of experiment adopted by the author was to condense the steam discharged from a nozzle in a current of cold water, measuring the total discharge of the water, and the rise in its temperature—a method based on the use of an ejector condenser. The method was considered correct to within a few thousandths. A series of tables is given showing the results of the experiments. Curves also are given of the results, and these curves show that the outflow of air and of steam are so much alike that the curves are almost superposable. There is the difference that the theoretical maximum for air occurs when the ratio $p : P = 0{\cdot}526$, whereas for steam the maximum outflow occurs when $p : P = 0{\cdot}58$.

The tabulated results are given in grammes per second. The tables are for various convergent nozzles and thin plate orifices of different diameters.

The curves show also the theoretical values deduced from calculation, which do not depart far from the experimentally-determined figures.

A practical formula for discharge is given as $W = 15{\cdot}20\ P^{0{\cdot}9725}$, where W = grammes per second per cm², P = pressure in kg. per cm². This formula is for convergent nozzles and a final pressure p less than $0{\cdot}58\ P$.

A final chapter deals with the flow of hot water through nozzles.

The problem is complicated by the evaporation of the water as the pressure falls, and no very conclusive results are given, owing to the difficulty of the mathematical analysis.

An appendix is given of the bibliography of the subject dating back to the year 1800.

Le Four Electrique: Son Origine, ses Transformations, et ses Applications. Part I. By Adolphe Minet. Paris: A. Hermann. 1905. Price 4s.

Les Fours Electriques et leurs Applications Industrielles. By Jean Escard, with a preface by Prof. Moissan. Paris: Ch. Dunod. 1905. Price 18 fr.

The boom in electric furnace literature continues, and it has now spread across the Channel. France is really the home of the electric furnace, and we hoped that she might have been spared this; she deserved a better fate. The malady, which is the invariable accompaniment of every great new industrial application of science, has taken the usual course. No sooner had the work of the pioneers, the Moissans, the Héroults, the Cowles, the Achesons, become spread abroad and its value duly appreciated, than up sprang a crowd of imitators who repeated the experiments of the great men and took out endless foolish patents, half of which, the original half, were useless, and the other half, the useful half, had already been anticipated by the pioneers. The age of stupid patents is unhappily still with us, and its terrors are now being aggravated by the symptoms of the "third period," the age of compilations, whose chief characteristic is the appearance of a formidable array of equally stupid books, few of which are really required or will ever be read (excepting by the author, the compositor, the printer's reader, and the unhappy reviewer—if conscientious), consisting, as they mostly do, of a tiresome jumble of the aforementioned stupid patents "selected," if one dare use such a word, without the slightest discrimination and with a reckless disregard of their utility, originality or value. But although all of this well represents the mood, the righteous, if savage mood, in which we write on taking up the two books now before us, we must beg of the reader not to suppose that these books particularly illustrate all the evils of the "age of compilations"; it might, indeed, be argued that even compilations, in limited numbers, have their value. In limited numbers: there's the rub!

M. Escard's volume purports to be, and so it really is in its way, a comprehensive treatise dealing with the subject from the theoretical, laboratory, and industrial standpoints, and covering the whole field of technological application which the electric furnace has up to the present claimed as its own. A book built on such a plan must necessarily suffer from the defects of its qualities. You may always be sure that a "comprehensive" treatise will contain an irritatingly large proportion of matter which has been published again and again *ad nauseam*, and M. Escard's volume unfortunately fulfils the expectation only too well. In the earlier chapters, for example, which deal with laboratory furnaces and their use as instruments of research in the chemistry of high temperatures, whole sections, page after page, pictures included, are almost literal transcripts from Moissan's "Le Four Electrique." Now this book is in many respects a commentary and a sequel to Moissan's pioneer treatise; surely it would not have been too rash to assume that the potential readers of the commentary would not be likely to be entirely ignorant of the text on which it is based. But then perhaps there are even some French electro-chemists who have never read Moissan. To such readers, and to all besides who would find it convenient to be able to refer to practically any aspect of the electric furnace without going beyond the compass of a single volume, M. Escard's book, which we should say is clearly and pleasantly written, will prove both useful and desirable, but one could not conscientiously say that there is here anything of substantial value not to be found in Moissan and Borchers, both of which can now be had in French, German and English.

M. Minet's book is only the first instalment of a work that is to be completed in five volumes. The subject is treated exclusively from the historical standpoint, and as the present section deals mainly with developments—generously illustrated with both furnaces and their inventors—which took place in the "Laboratory Period," 1808-1886, detailed criticism is uncalled for. Moreover, part of the book is practically an expansion of a classificatory paper which M. Minet read before the Faraday Society in 1904, and on that

paper we commented at the time. Up to the present, at least, we must confess that we do not find the book sufficiently readable to recommend to a student as a text-book on the subject, to be read from cover to cover. However, we await the remaining sections of the book with much interest, and when complete it should, if well indexed, form a very useful and necessary work of reference. From this point of view the classified bibliography, which forms an appendix to the book, is a useful adjunct, but there is a sprinkling of minor errors that will mar the value of the book as a work of reference, especially if any are allowed to creep into the remaining volumes.

The Municipal Engineers' Specification. Published by the Proprietors of *The Builders' Journal and Architectural Record.* London. Price 2s. 6d. net.

The only section of this annual publication which is likely to appeal to our readers is the fourth, which devotes some 14 sub-sections to electricity supply, and has been compiled under the general editorship of Mr. E. Kilburn Scott. Reading through specifications, when one is not a manufacturer desiring to tender, or an engineer seeking tenders for one's first scheme, is a tedious matter; yet some model form of specification is always likely to have its uses. For instance, it is not inconceivable that there may be a class of municipal central station engineers—some with greatness thrust upon them by the pull exerted by friends or relatives, and others whose greatness is the result of application (in more than one sense)—whose lot it may have been never to have drafted a specification under earlier chiefs, or perused it from the point of view of the manufacturer desiring to tender. Such a man, often well competent to run a station, and keep fuel costs down, and pressures regular, may perhaps be puzzled, when his particular committee having asked him to draft a scheme of station extensions, asks him to secure tenders for the machinery required. In such an eventuality, if experience in drafting specifications be lacking, the engineer of our imagination would invoke and obtain a few hints from professional friends, or by writing to a few steam engine builders, dynamo makers, and so forth, inquiring for particulars of their machines, would receive from each pushing sales department a draft specification for the generator or plant required.

This publication is intended to save the electrical engineer at home and the electrical engineer abroad from falling into this position, and draft specifications and forms of tender are provided under the following headings: (2) boilers; (3) economiser and coal conveyer; (4) overhead travelling crane; (5) piping, pumps, heater, &c.; (6) engines with accessories, dynamo machinery, &c.; (7) balancer, booster, &c.; (8) main switchboard testing instruments, connecting cables, &c.; (9) meters for house service; (10) accumulators, stands, acids, &c.; (11) cables, trenching, joint boxes, house service boxes, &c.; (12) arc and incandescent lamps and posts for private lighting, and (13) station lighting. To examine these closely were merely to pick upon details and suggest modifications thereof in the light of the reviewer's particular experience or fancies, and this is quite unnecessary, as anyone with any regard for the efficient maintenance of any station will be well able to do this for himself. Suffice it to say that apart from these admittedly useful features, the section possesses an educational interest, and is designed so as to engender the least possible friction between the municipality and the manufacturer, by suggesting the allowance of adequate time for tendering, and dealing with the provision and return of manufacturers' drawings, arbitration clauses. Special clauses with regard to payment, testing and shipment of plant for work abroad are also inserted. Although the earlier sections of the book which deal with sewage filtration, road construction, ambulances and other municipal luxuries do not concern the borough electrical engineer, the section with which we have dealt is worth the sum charged for the whole book. But we trust the publishers will not sell any copy to any member of a municipal body, lest it get into the hands of a member of the electrical committee, and the position of a borough electrical engineer extending his station become even less happy than before, by reason of the acquired knowledge (?) of the committee.

Electrical Influence Machines. By J. Gray, B.Sc. Second edition. London: Whittaker & Co. Price 5s.

This well-known little work is divided into three parts—viz., Phenomena and Leading Principles of Static Electricity, Description of Influence Machines, and Practical Construction.

The first portion discusses the leading principles very clearly; lines of force, &c., are explained graphically, and this to many readers, will be of great assistance.

The author has happily introduced the "Electronic Theory" in his chapter on the "Physical Theory of Electricity," and succeeds in giving a very clear account of it in an elementary way. The reviewer, however, thinks that perhaps the reference on pp. 51-52 to the Zeeman effect, and "circularly polarised doublets" and "plane polarised triplets" will be beyond the grasping power of the average reader.

On p. 41 there is the following reference to the familiar Crookes's cathode ray experiments:—

"These particles have been shown by Sir William Crookes to be capable of turning the vanes of a wheel, which disposes of the rival hypothesis that the cathode beam might consist of some process in the ether like the wave motion of light."

Now, this statement seems quite erroneous and misleading, since the maximum pressure generated by cathode rays is not more than one five hundred millionth part of an atmosphere per sq. centimetre, an amount much too small to account for the effects observed in the above experiment. J. J. Thomson regards it as an effect similar to that observed in a radiometer (*vide* p. 502, Conduction of Electricity through Gases).

Starke also has shown experimentally that when the vanes are arranged to eliminate the radiometer effects the mechanical effect is extremely small. For instance, a current of 10^{-7} ampere and a P.D. of 10,000 volts, gives less than 10^{-4} dynes per sq. cm.

The printers' devil has not omitted to do his work. On p. 189, "escaping steam," instead of "escaping stream"; and on p. 119, "a *furnace* furnished with metallic carriers," instead of "surface."

On pp. 138 and 291, in describing the Voss machine, the author points out that certain tinfoil disks with buttons of brass are fixed on the revolving plate, and that they are "said" to facilitate the self-excitement of the machine. Having worked a little with a Voss machine, the reviewer found that it worked perfectly *minus* the disks and brass knobs, and has arrived at the conclusion that these are "mystifiers," and are merely fixed on the plate by the enterprising manufacturers to make the "vulgus" respect the Voss machine, and induce them to think they are getting something for their money. Certainly the reviewer could detect no difference in the working of the machine with and without the disks, &c., whether starting up or not.

With regard to the reversal of the Voss machine, which is very annoying when using it for cathode ray work, the author does not appear to mention that when the machine reverses the current can often (not always) be quickly rectified by blowing hard across the disk from one comb to the other.

The chapter dealing with the efficiency of these machines, and Mr. Gray's QV diagram, is exceedingly interesting, and should be attended to by the designers of such apparatus. Even from a mechanical point of view these people might do much to improve their present "ramshackle" designs.

It would have enhanced the value of the book if the experienced author had added a chapter on the uses of these machines for "X" and cathode ray work. Mr. Gray could easily do this.

It is a relief in these days of shoddy electrical literature to read such a book as this, so carefully arranged, and well written, and certainly the standard work on influence machines in this country.

The poet of old must have been thinking of just such a book when he wrote:—

> Oh for a booke,
> And a quiet nooke,

but then, of course, that was in the days of "Amber soul."

LEGAL.

Burling *v.* Colchester Corporation.

At Colchester County Court on Friday, before Judge Tindal-Atkinson and a jury, Wm. Burling, formerly a motorman on the Colchester Corporation tramways, sued the Corporation for damages for alleged wrongful dismissal.

Plaintiff's contention was that because he had acted as chairman of a meeting of tramway employés held to ventilate alleged grievances, he was a marked man, as both he and the deputy-chairman had been discharged. He denied that he had used bad language on a car, that he had been guilty of negligent driving, or that on one occasion he had let go his handles in order to "let himself go" for the conductor.

On behalf of the Corporation, it was urged that the dismissal was justified, and that the dismissal was in consequence of endangering the safety of passengers by leaving the handles of his car. It was also argued that there was no case to go before the jury, because the rules of the department gave the Council the right to dismiss any one of their servants without notice.

The Judge pointed out that as there was a weekly engagement plaintiff could not recover more than one week's wages.

The Jury found for the plaintiff for £1 3s., one week's wages, and the Judge deferred the question of costs for further argument before him in London, when he would also decide whether, in point of law, and taking into consideration the rules or agreement under which the tramway employés worked, the plaintiff was entitled to even 23s.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Interested" writes:—"We should much value a reply in your 'Legal Query' column of the Electrical Review to the following:—We had a motor from the District Council on three years' hire. Nothing was said verbally, or in the agreement about a deposit being required. We fixed it and completed the wiring. The Council now refuse to connect up until a substantial deposit has been paid, and threaten to disconnect our service altogether, unless it is paid in seven days. Have they power to do this?"

*** If nothing was said in the written agreement as to a deposit being necessary, it appears to be clear that the Council have no power to demand it. It may be, however, that if "Interested" looks carefully at the agreement, the payment of a deposit will be found to have been provided for. It is impossible to say how far the Council have power to demand a deposit unless one sees the terms of the provisional order under which they work.

"R. C. A." writes:—"When incandescent electric lamps are guaranteed for 1,000 hours' life, can a contractor compel the manufacturers who supply the lamps to replace the number which gives out in, say, 300, 400 or 500 hours, or under the guaranteed number? If not, is there any set standard of hours in or under which, if a lamp gives out, it must be replaced? We have frequently been confronted with this question, and should be obliged for your opinion through the columns of your valuable paper, both from a general and legal point of view."

*** Treating the failure to supply lamps of 1,000 hours as a breach of warranty, the question put by "R. C. A." (who dwells across the border) appears to be answered by the Sale of Goods Act, 1893, Sec. 11 (2), which provides that in Scotland failure by the seller to perform any material part of a contract of sale is a breach of contract which entitles the buyer either within a reasonable time after delivery to reject the goods and treat the contract as repudiated, or to retain the goods and treat the failure to perform such material part as a breach which may give rise to a claim for compensation or damages. It is apprehended that the right of rejection could scarcely be exercised after a lamp had been burning for 400 hours, but it is clear that the purchaser would have the right to sue for damages. A threat of proceedings might have effect to persuade the seller to replace the old lamps.

BUSINESS NOTES.

Mica Boiler-Covering.—We have received from the Mica Boiler Covering Co. a copy of tests of Mica Sectional Boiler Covering. The makers lay special stress on their method of using mica in the sheet or large flake, so that it acts as a laminated structure, and must not be confounded with compositions of ground mica, to which such a property cannot be ascribed, for in the case of ground mica the little flakes lie in all directions, and do not enclose sheets of air. Test figures are given in support of the claims made, and show that for a weight much less than that of other coverings, and with a less thickness, the steam condensed per square foot of pipe surface per hour is very much less, the loss in B.TH.U. being only 0·544 per degree of difference between outside and inside temperatures.

Mica is, of course, fireproof, and from its curious property of an almost interminable lamination, such lamination can be developed by corrugated rolling, so that an infinity of air stratification is set up, with the result that a covering only 1 in. in thickness will reduce the condensation in a pipe to a sixth or an eighth of that of a bare pipe. Needless to say, all pipe coverings should be applied with even more than ordinary care to the flanges as well as to the barrels of pipes. Too often may be seen pipes with plastic coverings neatly tapered down near the flanges, so as to leave the bolt heads and nuts, the flanges, and an inch or two of the pipe body completely unprotected. This is an error fatal to efficiency, for the flanges are of great area, and when bare produce very severe cooling effects. Indeed, what is a pipe flange but a form of that very gill which is specially cast on pipes which it is desired shall radiate or otherwise lose as much heat as possible? It is one of the advantages of sectional coverings that the flanges of pipes can so easily be covered by special removable flange boxes, so that the loss of heat is thereby reduced to a minimum.

Approximately, with ordinary conditions as to pressure, the condensation in steam pipes, mica-covered, may be reckoned at a sixth of a pound of steam per square foot of pipe per hour. This loss may be reduced by thicker covering, but beyond the first inch, or inch and a half, the increase in the saving grows rapidly less, and in time is not sufficient to pay the interest on the covering. Coverings must, therefore, be proportioned to suit first cost with this point in view, and it should be remembered that with durable coverings the first cost may be increased beyond what would be desirable for less durable materials. Since air is cheaper and better than any other insulating material, the cheapest cover is that which imprisons the most layers of air in an absolutely quiescent state. Such mica is calculated to do.

Electrical Developments in Japan.—The fifth Financial and Economic Annual from Japan, issued from the Government Printing Office at Tokio, shows that that very wide-awake Eastern Power has not much to learn except in regard to the elimination of some technical obscurities from Western statisticians, if pertinency of the facts published, and lucidity in arrangement be taken as the standards of comparison. It contains information for inquirers of all classes and professions, and from its pages the following notes have been compiled.

Electric Motors in Factories.—In 86 different factories only electric motors are employed, these amounting in the aggregate to 125 in number, and to 5,233 H.P. in power. Electric driving is chiefly to be found in the textile and machinery factories, 22 motors aggregating 431 H.P. being found in the former, while the similar total of 22 motors, aggregating 299 H.P., are found in the latter. Of this total, 24 H.P. is employed in machine-making factories, 150 H.P. in ship yards, 115 H.P. in tool and implement factories, and 10 H.P. in foundries. In what are classed special workshops, 32 engines, aggregating 4,082 H.P. are to be found, 21 of which, of 3,500 H.P., are to be found in "electricity works," the balance being found in metallurgical works.

Electric Lighting Companies.—A return is given showing the progress under this heading from 1894 to 1903. In the latter year, some 60 companies were in operation; these are recorded as having a reserve fund equal to one-twelfth of their paid-up capital, and possessing lines 598 ri in length, and wires 2,045 ri in length. (The ri = 2·44 miles. A footnote carries this equivalent out to the eighth decimal place.) The number of houses furnished with the electric light is 69,328, and the value of the lamp connections is expressed as 296,872 watts, while 222 houses are furnished with motors aggregating 687 H.P. The coal consumed by the electric supply companies amounted to 147,100 tons, and the dividends distributed were equal to nearly 11 per cent. on the paid-up capital.

Electric Tramway Companies.—The latest return for these is dated December 31st, 1904, and deals with 17 undertakings, having a paid-up capital of 21,343,954 yen. (The yen is equal to slightly over 2s. sterling.) The mileage of line then open for traffic amounted to 118·57 miles, while 49·12 miles were under construction. The rolling stock consisted of 811 cars, and the total number of passengers carried during the year was 73,341,250. The mean rate of dividends paid amounted to 3·88 per cent. Considering that the first electric tramway in Japan was opened in Kyoto in 1895 when a national industrial exhibition was held in that city, the results chronicled are certainly satisfactory.

Electrical Imports and their Source.—The total value of the electric motors imported was 1,466,186 yen, of which two-thirds of the value, or 812,226 yen came from the United States, while 228,486 yen came from Great Britain, and 222,398 yen from Germany. Electric cars or carriages, which had a total value of 905,768 yen, also came mainly from the United States (783,699 yen), Great Britain being a poor second (111,369 yen). In regard to submarine telegraph cables and underground telegraph lines or cables, the total value imported was 1,036,961 yen, of which the value coming from Great Britain was 995,987 yen.

Private Telephones.—The warehouses and factory erected by Messrs. Eastman & Sons, Acton Vale, are now being installed with a complete intercommunication telephone system by Messrs. Yeoman & Co., of Telegraph Street, E.C.

Rubber Exhibition at Ceylon.—According to the *Daily Chronicle*, the Government of Ceylon has arranged for the holding of a rubber exhibition, open to manufacturers, at Peredeniya at the end of April.

Dissolutions and Liquidations.—Wm. Aug's Gibson, Ltd.—A meeting is to be held at 34, Old Broad Street, E.C., on February 5th, to hear an account of the winding up from the liquidators (Messrs. W. A. Gibson and R. Lawson).

Electro-Sulphur and Light Syndicate.—A meeting is to be held at 61½, Fore Street, E.C., on February 8th, to hear an account of the winding up by the liquidator (Mr. E. T. R. Wilde).

Power Saving Pulley Co.—Messrs. T. A. Smith, T. Graham, and E. A. Young, engineers and power specialists, of Manchester, Birmingham and London, have dissolved partnership. Mr. T. A. Smith will attend to debts, and will continue the business at Arcade Chambers, St. Mary's Gate, Manchester.

Messrs. Alfred J. Boult, Harold Wade, B. E. Dunbar Kilburn, and Wm. Jno. Tennant, chartered patent agents, have dissolved partnership by mutual consent. Messrs. Boult, Wade and Tennant will continue to practise in partnership at the same address (111 and 112, Hatton Garden, E.C.), under the style of Boult, Wade and Tennant. Mr. B. E. Dunbar Kilburn will carry on practice in his own name at Chancery Lane Station Chambers, High Holborn, London, W.C.

St. Helens Cable Co., Ltd.—This company is winding up voluntarily with Mr. Arthur Wenham, 10, Walbrook, London, E.C., as liquidator. Creditors are to send particulars of their debts, &c., to the liquidator by February 13th.

Atmospheric Electrical Purification Co., Ltd.—The company has resolved to wind up voluntarily with Mr. E. E. Groome, 21, Spring Gardens, Manchester, as liquidator.

Shanghai Electric Tramways, Ltd.—The company has resolved upon voluntary liquidation with Mr. G. G. Walker, 19, St. Swithin's Lane, E.C., as liquidator. Creditors must send in particulars of their debts, &c., by February 8th.

The Motor Traction Co., Ltd.—Voluntary liquidation has been decided upon, with Mr. John Baker, Eldon Street House, E.C., as liquidator.

The Schmidt Portable Engine Co., Ltd.—A meeting is to be held at Broad Sanctuary Chambers, Tothill Street, S.W., on February 7th, to hear an account of the winding up from the liquidator, Mr. W. E. Davies.

Messrs. Rooper & Harris, Ltd.—At a meeting to be held at 55, Cornmarket Street, Oxford, on February 5th, the liquidator (Mr. A. E. Preston) will give an account of the winding up.

Special Telephone Directories, Ltd.—This company meets on February 7th at 16, Philpot Lane, E.C., to hear an account of the winding up from the liquidator, Mr. Frank Cook.

Catalogues and Lists.—Messrs. Dorman & Smith, Salford.—New pocket edition of their catalogue, illustrating and pricing many of their lines of switches, fuses, cast-iron fittings, brass ships' fittings, &c. Calendars for 1906 and 1907 are printed at the beginning, and some tables of wires and conductors, resistances of copper and candle-power efficiency, are followed by a number of pages for memoranda.

Messrs. Ferranti, Ltd., Hollinwood.—Catalogue No. 55 of triple-pole double-throw quick-break knife switches.

The British Thomson-Houston Co., Ltd., Rugby.—Illustrated pamphlet No. 189 on the B.T.H. Meridian lamp, its chief points and advantages. Some excellent views of art fittings carrying lamps of this type appear.

The Commuroid Co., 85, London Wall, E.C.—List relating to "Commuroid" which is a solid form of lubricant for motors, giving directions for its use, also price. We have received a sample stick.

Messrs. Bergtheil & Young, Ltd., Camomile Street, E.C.—Price card of "Bandy" small power motors.

Sterling Telephone and Electric Co., London, E.C.—List of "Hygienea" telephones, announcing a recent increase of 5 per cent. in prices consequent upon the continued serious rise in the price of raw material.

Messrs. H. G. Mayer & Co., 67, Aldersgate Street, E.C.—Illustrated pamphlet relating to the carbon works of Messrs. Schiff & Co., of Schwechat, near Vienna, and the various processes entailed in the manufacture of arc lamp carbons, electrodes, carbon brushes and galvanic plates. Photographic views of some of the departments appear.

The Birmingham Guild of Handicraft, Ltd., 45, Great Charles Street, Birmingham.—300 p. book of designs of artistic electric light fittings, such as brackets, ceiling fittings, standards, pendants, also switch covers and plates, wall sockets and plug covers. The book is fully and well illustrated.

Messrs. Thos. Piggott & Co., Ltd., Birmingham.—Circular relating to their welded pipes which they supply complete in any length.

Monte-Callow Co., 6, Ludgate Broadway, London, E.C.—Set of illustrated sheets in expanding binder, describing and pricing the "Emsea" motor control panels, switch and oil switchgear, overload releases with time lag, enclosed switches and fuses, measuring instruments and resistance units.

Cryselco, Ltd., Kempston Works, Bedford.—Several new lists and pamphlets particularising their various standard lines of British-made incandescent lamps, also the tubular, flame, "Alfa-megga," and "Cryselco Perfect" types. One of the lists contains dimensioned outline sketches of standard bulbs, and prices of lamps for various voltages and candle powers.

The General Electric Co., Ltd., London, E.C.—New edition of Section P catalogue (12 pp.), containing specification and tabulated data relating to the "Witton" single, two and three-phase generators with stationary armatures and revolving fields. Some excellent photographic views appear of the Dublin Corporation three-phase generator (already illustrated in our pages), a 1,200-K.V.A. slow-speed generator for Cardiff Corporation, some 1,350-K.V.A. three-phase generators as supplied to the East Rand Proprietary Mines, Johannesburg, also plants for Woolwich and Fulham.

Crosby Indicators.—The Crosby Steam Gage and Valve Co., 147, Queen Victoria Street, E.C., have sent us a leaflet (No. 1,050) which deals with the Crosby indicators, detailing their special features. Among others shown is one fitted with a continuous drum. This instrument is claimed to be particularly serviceable for indicating engines where the pressure or load varies, such as winding or rolling mill engines, a full-sized diagram being taken at each stroke of the engine. If desired, the drum can be operated so that only the ordinary single diagram is taken. The company's latest pattern of indicator is also shown; it is an instrument with the spring outside and above the cylinder, where it will remain cool under all conditions of use, either with steam or gas engines. This indicator is fitted with a piston double the area of the company's ordinary pattern indicator, thus affording a greater active force with a light pencil mechanism. The sides of the piston are spherical, so that the contact with the interior side of the cylinder is a line, thus eliminating to a large extent any friction between the piston and the inner wall of the cylinder. Another speciality is the Crosby reducing wheel, which is shown attached to an indicator, and which is said to have much simplified the work of indicating, as by its aid the stroke of the engine is reduced to the length of the diagram required to be taken on the indicator drum, without the necessity of erecting levers or other stroke-reducing devices on the engine. Another leaflet, No. 1,051, shows various styles of the Crosby spring-seat steam valves. A special feature is the large iron body valves, with steel pillars and crossbar.

Book Notice.—*Science Year Book for* 1906. London: King, Sell & Olding. Price 5s. net.—This excellent year-book, now in its second year of issue, retains all the advantages of its predecessor, and has been considerably enlarged as well. A portrait of Sir William Huggins, retiring President of the Royal Society, forms the frontispiece. New astronomical and meteorological maps and tables have been inserted, together with many new physical and other data. A list of Universities with Professors of Science has now been included (can we imagine *any* University being absent from this list?), and a list of Colonial Scientific Societies, as well as a bibliography for 1905. In common with our friend, the editor of *Electricity*, we notice our entry in the Directory of scientific periodicals is slightly inaccurate. As in the previous issue, the summaries of scientific progress during the year are excellent; electro-technics is dealt with by Prof. W. E. Ayrton, F.R.S. The diary provides ample space for entries, and gives information on each page corresponding to the day and date. The whole production, which is edited by Major B. F. S. Baden-Powell, President of the Aeronautical Society, is unique, and its general get-up is beyond praise. It is interesting to note that any page can be had separately, for the convenience of those who require a copy or copies of a particular table, map, or summary.

West Australia.—A 500-ampere-hour D.P. battery and Crompton hand reversible booster with switchboard and accessories have recently been shipped out to Bunbury, West Australia, to the order of Mr. Frank Broadbent, consulting engineer, acting on behalf of Messrs. Splatt, Wall & Co., Perth, West Australia. The booster, which was designed for 100 amperes charging current at 60 volts, and 200 amperes discharging at 30 volts, was put through a severe test before dispatch, the motor standing temporarily double its rated load.

Trade Announcements.—From January 1st, the business carried on for the last 30 years by Mr. W. H. Baughan, trading as Baughan & Co., manufacturing electricians and contractors, will be transferred to his son, Mr. A. H. V. Baughan, who will continue to trade under the same name. Any firms having claims against Mr. W. H. Baughan should send in a statement of same for settlement.

Messrs. Pritchetts & Gold, Ltd., have taken offices at 20, Victoria Street, S.W., and on and after January 8th, all communications respecting prices and quotations, and all orders, should be addressed to London and not to Feltham as heretofore. Correspondence *re* the dispatch of goods and execution of orders should be addressed to the works at Feltham.

Messrs. G. Harland, Bowden & Co., Glasgow, are making a special feature of shipyard work. They have just secured the important contract to instal complete power in the Camperdown Shipyard, Dundee, and have a Clyde order in hand. They have recently supplied complete equipment to Messrs. D. I. Dunlop and Co., shipbuilders, Port Glasgow, and have also executed lighting and wiring for Messrs. Russell & Co., who hold the Clyde record for the largest number of vessels launched in 1905.

American Electrical Exports.—There was a marked decline in the exportation of electrical machinery from the United States during October last, the returns just to hand showing a total of only £105,533 as compared with £132,253 in the corresponding month of 1904. Canada continues to be America's best customer for electrical machinery, being responsible for £36,460 of the October total, England being second with £16,360. As regards the exportation of electrical appliances, these show a noteworthy increase from £70,480 in October, 1904, to £90,844 in October last.

For Sale.—The Leeds Corporation electric lighting department is offering certain electric generating plant for sale. It is to be replaced by larger plant. See our "Official Notices" for particulars.

Calendars and Diaries.—Many of our readers received a year ago a handy perpetual desk calendar from the ARMORDUCT MANUFACTURING CO., LTD., of Farringdon Avenue, E.C. They will be glad to learn that the company has just issued a set of refills for this calendar for the year 1906. By the use of this detail of office equipment one is able to enter one's engagements on daily slips, and conveniently keep them ready for reference as a record after the engagements have been fulfilled.

A pocket diary which we should miss very much did it fail to appear, is that of the BRUSH ELECTRICAL ENGINEERING CO., LTD. It is extremely neat, convenient in size, is accompanied by accident insurance policy, and the one for 1906 will be our constant vest-pocket companion, as previous editions have been for some years past.

MESSRS. J. HALDEN & Co., Great Chapel Street, Victoria Street, S.W., have, as usual, issued a hanging wall calendar with monthly tear-off sheets for 1906. Circulars relating to the firm's drawing office instruments and materials are placed between the calendar sheets.

The BIRMINGHAM ENGINEERING CO., LTD., of Hooper Street, Spring Hill, Birmingham, has sent us a calendar card for 1906.

From MESSRS. W. H. WILLCOX & Co., LTD., of Southwark Street, S.E., we have received one of their wall date remembrancers for the year, with tear-off monthly sheets.

From MESSRS. STEGMANN & Co., of Clapham Junction, there has come to hand a very good desk or hanging calendar with aluminium frame.

A hanging calendar for 1906 has been received with monthly tear-off slips from MESSRS. PARMITER, HOPE & Co., of Manchester.

From THERMIT, LTD., of London, a calendar brings the compliments of the season. Seven photographic views of the company's welding system in process of application are embodied in the general design.

A serviceable desk calendar with bold and distinct figuring has been received from the ELECTRIC CONSTRUCTION CO., LTD. It has a separate card for each month.

A useful blotting pad with diary at left-hand side has reached us from the COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO., LTD. The blotting pages of the diary each have a message appropriate to the period of the year, for the user, driving home the necessity for electric lighting and the fact that the company only charges 3¾d. per unit. The diary has the usual insurance coupon, as has also a very acceptable vest pocket diary that the same company has also sent us.

Once again the HART ACCUMULATOR CO., LTD., is circulating its blotting pads, with top pocket, among its numerous friends.

The BRUSH ELECTRICAL ENGINEERING CO., LTD., has issued a large wall calendar of very artistic design. The Loughborough works are shown in colours above a block of daily tear-off slips bearing Charlotte Bronte selections for the edification of the user. Half-tone views of Brush rolling stock are arranged about this block.

Advance in Prices.—MESSRS. H. W. SAMBIDGE & SON, of Highgate Street, Birmingham, announce alterations in discounts consequent upon continued advances in the price of metal.

The SLOAN ELECTRICAL CO., LTD., is announcing an advance in prices for carbons, cables, flexible cords, and electrical accessories owing to increased cost of raw materials.

Brush Contracts.—The following contracts have been booked by the BRUSH ELECTRICAL ENGINEERING CO., LTD.:—

For Scott, Stirling & Co., Twickenham.—25 double-deck omnibus bodies.
For the Bury Tramways (per Westinghouse Co.).—Six single-deck car bodies.
For the Greenock and Port Glasgow Tramways.—Three double-deck car bodies complete, mounted on radial trucks fitted with Brush 1202B motor equipments.
For Leyton.—Two 500-KW. Brush-Falcon reciprocating steam engines.
For the Great Northern Railway Co., of Ireland (per Manning & Wardle).—Four motor coaches complete with trucks.

Silver Medal.—At the recent Smoke Abatement Exhibition, MESSRS. MELDRUM BROS., LTD., were awarded the silver medal for their refuse destructor, this being, we understand, the only award of any kind for refuse destructors.

A Year's Progress.—At the commencement of 1905 MESSRS. ERNEST SCOTT & MOUNTAIN, LTD., were still in possession of the old works in the Close, Newcastle-on-Tyne, where manufacturing was being carried on under great difficulties owing to want of space. New works were erected at Gateshead, and such of the old shops as could be made use of were renovated, and the whole place was ready for occupying about the end of April, 1905. The change from the old works to the new naturally caused considerable dislocation of work, but was effected without serious stoppage by means of a transference of the different departments at different times. During the year the firm have completed some large contracts, including, amongst others, the following:—Electric generating machinery for Messrs. Bell Bros., Ltd., Iron and Steel Works, Port Clarance, consisting of a 450-KW. continuous-current dynamo and a horizontal slow-speed steam engine. A similar set with coupled compound Robey engine was also supplied for the same station. For the Consett Iron Co., County Durham, the firm have completed what is believed to be the largest pumping installation in the country. This plant consists of two Scott & Mountain 500-H.P. three-crank compound enclosed engines and dynamos which supply power for driving the pumps, and also for electric lighting throughout the works. The pumping station is situated about 1,000 yards from the engine house and adjoins the two new reservoirs which have been constructed by the Consett Co. In the pump house there are three Scott & Mountain three-throw ram pumps, having a capacity of 1,500 to 2,000 gallons of water per minute while working against a head of 300 ft. The firm made the whole of the engines, dynamos, pumps and motors. They also supplied to Messrs. Cammell, Laird & Co., of Sheffield, one of their high-speed enclosed compound engines direct coupled to a 450-KW. dynamo, and also another generator of similar size for mounting on the crankshaft of a compound slow speed horizontal engine. At the present time the firm are completing an important contract for the Alquife mines and railway companies of Spain. These mines are the property of the Coltness Iron Co., of Glasgow, and the Millom and Askam Co., of Cumberland, and the whole plant will be driven by electric current generated by water power in the district. Other work now in hand includes a large colliery installation for the Wigan Coal and Iron Co. for their Manton Colliery, this plant consisting of two 500-KW. three-phase generators directly mounted on the crankshafts of slow speed engines. This installation includes pumps, haulage gears and other auxiliary machinery in the colliery. For the Kent Collieries, Ltd., the firm have just secured a contract for an electric pumping installation to deal with an accumulation of water in the shafts which has for some time interfered with progress. In this case the whole of the machinery will be manufactured at the new Gateshead works, and includes engines and generators, special centrifugal pumps with electric motors for lowering down the shafts. In a similar connection the firm are supplying to Messrs. Barber, Walker & Co', for their colliery near Doncaster, two electric motors for driving centrifugal pumps, also two three-phase generators for direct coupling to the exhaust steam turbines of the Rateau type. Messrs. Barber, Walker have also purchased from the firm one of their enclosed three-crank compound engines and 400-KW. three-phase alternators. The firm's operations are, of course, not confined to the United Kingdom, but include, as mentioned above, the plant for the Alquife Mines, in Spain, and also a large and important contract for the Bengal Coal Co., India, this latter plant consisting of electrically-driven haulage and winding gears, pumps, &c. Messrs. Scott & Mountain's machinery is now being supplied to many of the largest colliery companies in this country, and considerable shipments are made to China, Straits Settlements, Australia, New Zealand, the Cape, &c.

Faraday House.—We have received a neat little booklet from the Electrical Standardising and Testing Institution, of Faraday House, Southampton Row, giving particulars of the work done by the Institution, scale of fees for testing, &c. Views are given of the large rooms and laboratories, workshops, &c., which are now at the command of the staff in the new building, and which are specially arranged for the quick and accurate testing and calibrating of electrical apparatus and materials of all kinds. It is interesting to note that the testing department is kept entirely separate from the teaching side of the Institution's work, with a special staff exclusively employed in its service, though the advice of the principal, Mr. Hugh Erat Harrison, and of Mr. Alexander Russell and Mr. J. Thomas, is available when required.

Consular Notes.—SOUTH AFRICA.—The following extracts (reprinted from the *Financier*) are taken from a recent report by U.S. Consul Snodgrass, of Pretoria. The advice, which is that of an American to Americans, will doubtless be studied with care and deliberation by English electrical manufacturers:—

"Africa, both north and south, is an important customer for electrical supplies of every description, and although the British firms have been capturing the majority of contracts, due to their being on the ground floor, it is evident that the United States can come in for a larger share of the trade by the prosecution of an energetic campaign, and by having competent and forcible men in the field. Our trade has been falling off this year, the last month reported being May, in which there was a decrease in the shipments of electrical machinery from the corresponding month of 1904 of 2,800 dollars.

"The great activity in the electrical trade is not by any means confined to South Africa, for in Egypt and other northern provinces large electrical problems are under consideration. As an instance, the Soudan Government is considering the introduction of an extensive electric tramway system into Khartoum. Neither cables nor overhead wires will be used, the intention being to store the electric power in the cars. It is expected that the system will be extended to Omdurman. Public and private installations of the electric light on an extensive scale, electrical power, &c., are under consideration, and for years to come Egypt will be sending out orders to the firms whose names are kept to the forefront, so that it behoves American companies to keep their eyes open for that trade, which alone will run into the millions. As the British are in control in Egypt, they look upon that field as part of their Empire.

"In South Africa, especially in the Transvaal, the demands on electrical engineers are multiplying to an enormous extent, as the mines are running as never before since the introduction of Chinese labour. There appears to be a feeling of optimism among the little cities, as well as among the larger ones, which is bringing about a large expenditure for utilities. Electrical hoists are being installed in nearly all the mines; electrical elevators (lifts) are being placed in many of the business houses and in the tall buildings of Johannesburg, and in nearly every town of any importance some large electrical project is either in hand or in contemplation.

"In the city of Pretoria, a place of 30,000 people, which has come to the front since the conclusion of the war like a boom town of the West, the citizens have been worrying along with a horse-car line which penetrates the centre of the city, and has perhaps three miles of track. The Town Council is arranging to convert it into an electrical system at an outlay of several millions, it being the intention to lay 15 or more miles of track throughout the municipality, and also to connect the numerous suburbs lying within a radius of five or six miles.

"At Johannesburg several millions were spent in installing an electric tram system, but practically all the contracts were captured by representatives from Scotland and England. Most of the apparatus to be used was shipped by the ill-fated steamer *Clan Monroe*, which was wrecked near Cape Town some weeks ago, so that it was necessary to duplicate the order through the same firms. At Volksrust and Klerksdorp it has been decided to erect lamps, and I might go on multiplying instances in which electrical developments are being carried on.

"If Americans care for this trade they will have to wage a war for it against the Britishers, who are on the ground and are in possession of the country. It will be difficult to wrest it from them. However, as America has captured the mining machinery trade on the Rand from all competitors, even under British rule, it can do likewise in the electrical field if the same amount of energy, concerted effort and brains is expended as was laid out by the pioneers in the goldfields."

The Dance of the Lamp-Makers.—On Saturday last the employés of the Robertson Lamp Co. held their Annual Christmas Dance in the large hall of the Robertson Lamp Works, at Brook Green, which was specially decorated by the members of the Works Club for the occasion. The evening's entertainment was a great success, there being about 400 employés and their friends present. Mr. Hirst, the chairman of the company, with Mrs. Hirst, Mr. and Mrs. Max Byng, Mr. and Mrs. Robertson, Mr. Wilson, the manager, and Mrs. Wilson, and several other guests, were present. The dancing lasted from 7.30 until 12 o'clock.

LIGHTING AND POWER NOTES.

Boston.—The T.C. has decided that it is not prepared to give consent to the application of the National Provincial Electricity Corporation for a prov. order for E.L.

The B. of T. has written asking the Corporation's opinion as to whether the 1900 E.L. order should be allowed to remain in force.

Brighton.—The *Sussex Daily News* states that the Corporation has received a communication from the L.G.B. on the subject of the recent inquiry into the application for sanction to borrow £38,500 for E.L. purposes, and £5,909 for the purchase of a site for, and the erection of, buildings in connection with the undertaking. It is understood that the board is willing to sanction the loan for the latter, but the question of the larger amount is held over.

Canada.—Grand Forks.—A contract has been awarded by the West Koortenay Power and Light Co. for the construction of a power line from the North Fork River to the summit of Hardy Mountain.

Charlottetown, P.E.I.—The City Council has decided that unless the local light and power company rescinds its decision to increase its charges for light and power, it will put down a municipal plant.

Ottawa.—The contract between the city and the Ottawa Electric Co. for the lighting of the streets has been cancelled. The contract entered into in 1904 provided that the C.C. should have the right to cancel the same at any time, but that such cancellation would require two years' notice. The value of the contract is about $26,000 per annum, the number of lamps being about 500, each costing $52.

Cardiff.—From a local paper we learn that the Ely Paper Mills are to be operated by electric power. The proprietors have placed orders for the erection of 600 H.P. of generating plant as well as some 26 motors, varying in size up to 60 H.P. The question of taking a supply of energy from the Corporation or the South Wales Power Co. was considered, previous to this decision to put down a private plant.

Chili.—A concession has been granted for the supply of the town of Los Andes with electricity for lighting and power.

Continental Notes.—Italy.—Messrs. Conti & Co., of Milan, have been granted permission by the Novarra municipality to erect a water-power plant on the River Ticino at Trecate for electricity supply purposes.

France.—A report on the electric lighting of Paris has been submitted to the Municipal Council, and the latter has placed its recommendation before the Committee on the proposed city budget. The recommendations are: (1) All who desire to make propositions regarding the future electrical *régime* in Paris (monopoly, leasing, concession, adjudication of contracts for energy in bulk, contracts with distribution companies by retail, repurchase of stations and distribution networks, &c.) are invited to present schemes before March 1st next; (2) should the policy finally decided upon render a temporary arrangement necessary, the authorities are invited to receive and consider, in addition, all proposals during the period of temporary arrangement, and decide upon the prolongation of the same or for an entirely new provision regarding the electric lighting in 1907.

Dorchester.—The T.C. has applied to the B. of T. for an order amending its E.L. order of 1901, enabling it to transfer the authorised undertaking to a company.

Dudley.—The Corporation has been recommended by its Committee to agree to the Midland Electric Corporation supplying electric power to a manufacturer at Old Hill, until the municipality is in a position to do so.

Fenton.—The Hanley T.C. has approached the U.D.C. relative to the lighting of the district by electricity, and the Council has decided to receive a deputation on the matter. A Committee of the U.D.C. has already received a deputation from the Stoke-on-Trent T.C. relative to the E.L. question.

It has been reported that the U.D.C. is considering the question of applying for a prov. order under which Stoke may supply electricity to the district.

Golcar.—The U.D.C. has granted permission to the Huddersfield Corporation to carry an overhead wire for E.L. purposes from Cliffe Ash to Wellhouse and Cremble, the Corporation agreeing to indemnify the Council against any damage that may accrue therefrom.

Ilford.—For E.L. extensions to Goodmayes, a L.G.B. inquiry was recently held into an application to borrow £5,000.

India.—Mussoorie.—From *Indian Engineering* we gather that this municipality has fully considered the hydro-electric scheme, and the Brush Co.'s tender has been recommended for acceptance. This is contrary to the advice given by the Indian Government's electrical adviser; the tender he recommended was about £750 higher.

Lancaster.—The T.C. has decided to supply energy to the new works of the London & North-Western Railway Co. at 1½d. per unit, subject to a minimum consumption of 42,000 units per annum for seven years being guaranteed.

Llanrwst.—In regard to the public lighting of the town, the U.D.C. apparently requires the local supply company to remove its overhead wires and place them underground. The company has informed the Council that, at the expiration of the street lighting contract, it will remove the poles and wires where erected. According to a communication from the B. of T. on the question, the company deems that the demand for electric lighting does not justify the expense of laying underground mains or providing iron poles in place of the wooden ones now in use. The Council is indignant over the company's attitude, and fears that it may have to incur the expense of re-installing gas lamps. The B. of T. has been asked to insist on the mains being placed underground forthwith.

London.—Marylebone.—The B.C. generating station in Richmond Street and Lisson Grove, is approaching completion, and the Finance Committee has reported that it will shortly be necessary to take up further loans for the alteration of works and mains and meters.

Bethnal Green.—Until the B.C. is in a position to supply electrical energy itself, it has agreed to the Hackney B.C. supplying two firms within the Bethnal Green area.

Mitchelstown.—A L.G.B. inquiry was held recently into the application of the R.D.C. to borrow £2,000 for a scheme for the electric lighting of the town.

Newport.—An electrical exhibition, under the auspices of the Corporation Electricity Department, is to be held in the Drill Hall.

New Zealand.—New Plymouth.—The municipal E.L. scheme, costing about £7,000, is nearing completion. Water-power is utilised to drive the generators. The two turbines are of the double vortex type supplied by Messrs. Gilbert Gilkes & Co., of Kendal, of a capacity of 67 H.P., and are designed to run at 750 r.p.m. The Brush Co. has supplied the alternators, which each have an output of 45 KW. at 2,300 volts, 50 cycles, single-phase. The exciters are coupled direct to the generator shaft. The energy is transmitted from the power station overhead to a transformer station, 4½ miles distant, where it is transformed down to 440 volts, supply being on the three-wire system. The street lamps at present decided upon are 8 arc lamps and 130 32-C.P. incandescents.

Auckland.—The City Council has agreed to the Tramway Co. giving a supply of energy for lighting, pending the Council being in a position to contract for such a supply.

Rawtenstall.—The T.C. has received from the L.G.B. sanction to borrow £12,000 for carrying out the E.L. order.

The Lancashire Electric Power Co. has the sanction of the T.C. to the erection of overhead mains across the moors on the south side of the borough in lieu of underground mains, as shown on the deposited plans.

Renfrew.—The Clyde Valley Electrical Power Co. has now laid cables across the River Clyde, and is supplying power to Renfrew and district.

Scottish Mining.—An electrically-driven winding plant has been installed at the shale pit of the Tarbrox Oil Co.

South Africa.—Durban.—The E.L. Committee has recommended that the charge for future overhead connections be reduced from £2 to £1. The Committee also resolved that a tender received by the borough electrical engineer from Messrs. Babcock and Wilcox, for a new boiler to replace two smaller ones be accepted, at a cost of £2,215, including mechanical stoker and superheater. Tenders are also to be called for extensions to the power station buildings. The electrical engineer is to arrange for an electrical exhibition, to be held probably in February.

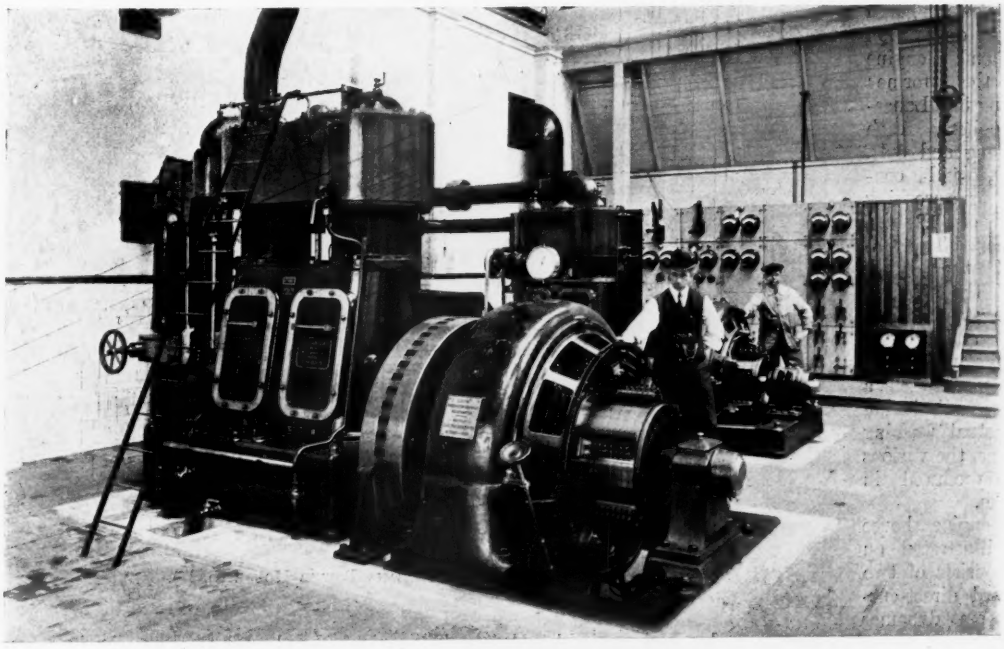
(*Continued on page* 23.)

THE ELECTRICAL EQUIPMENT AT MESSRS. J. HOPKINSON & CO.'S WORKS, HUDDERSFIELD.

The works of Messrs. J. Hopkinson & Co., at Huddersfield, have long been familiar to engineers in this country as the prolific source of the well-known "Hopkinson" steam fittings.

The business was established in 1843, and owing to the increasing demand for the firm's specialities, a new Britannia Works was built in 1904; the latter works occupy some 4 acres at present, of the 13½ acres which have been reserved by the firm.

The buildings consist of a large machine shop for dealing with the extensive series of boiler mountings, valves (ranging from ½-in. to 20-in. bore), steam and water gauges and miscellaneous fittings in which the firm specialises; adjoining brass and iron foundries; warehouses, stores and an administrative block, the latter containing spacious offices and dining rooms.



Generating Plant in the Power House, Messrs. Hopkinson's Works.

View showing Motors Driving Line Shafts, in the Machine Shop.

The manufacturing floors throughout are on one level, and all the departments are connected together by means of

tramways; further facilities for handling work are provided in the numerous electric and other cranes distributed through the works.

The whole of the works is driven and lighted by electricity, generated in the works power station, which together with the iron foundry is isolated from the main building.

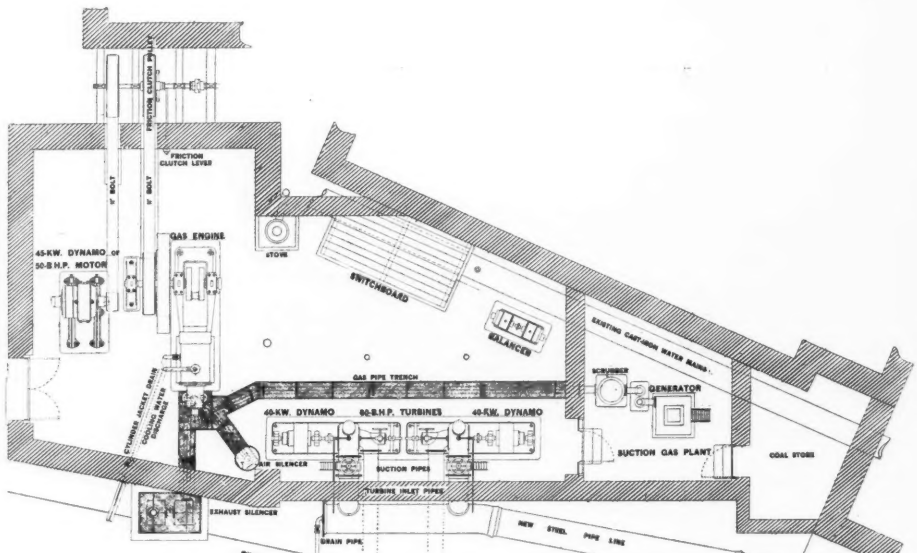
The power house buildings comprise boiler and engine rooms, the former containing two Lancashire boilers, each 30 ft. long and 8 ft. diameter, and constructed for a working pressure of 180 lb. per sq. in. The feature of the boiler house is the arrangement of steam pipes, valves, and boiler mountings, which has been adopted with a view to displaying under actual working conditions, the various fittings produced in the works.

The engine house plant (illustrated on p. 19) consists of two high-speed direct-current steam dynamos generating at 220 volts pressure, and a main switchboard for controlling the works power and lighting circuits.

The generating sets consist of a Belliss two-crank engine direct coupled to a 275-kw. E.C.C. multipolar compound wound dynamo, running at 380 r.p.m.: and a smaller two-crank engine direct coupled to a similar 150-kw. dynamo of Westinghouse make, with a speed of 450 r.p.m.

The switchboard, situated at the end of the engine room, consists of two dynamo panels, two panels for controlling the works lighting, and a further one for the power circuits.

The generator panels are each equipped with a triple-pole main switch and a circuit-breaker on the negative side: the feeder panels (lighting and power) control six separate feeders leading to distribution and sub-boards situated in convenient positions. All the feeders and distributors are of lead-covered paper-insulated cable, provided with additional armour in exposed positions.



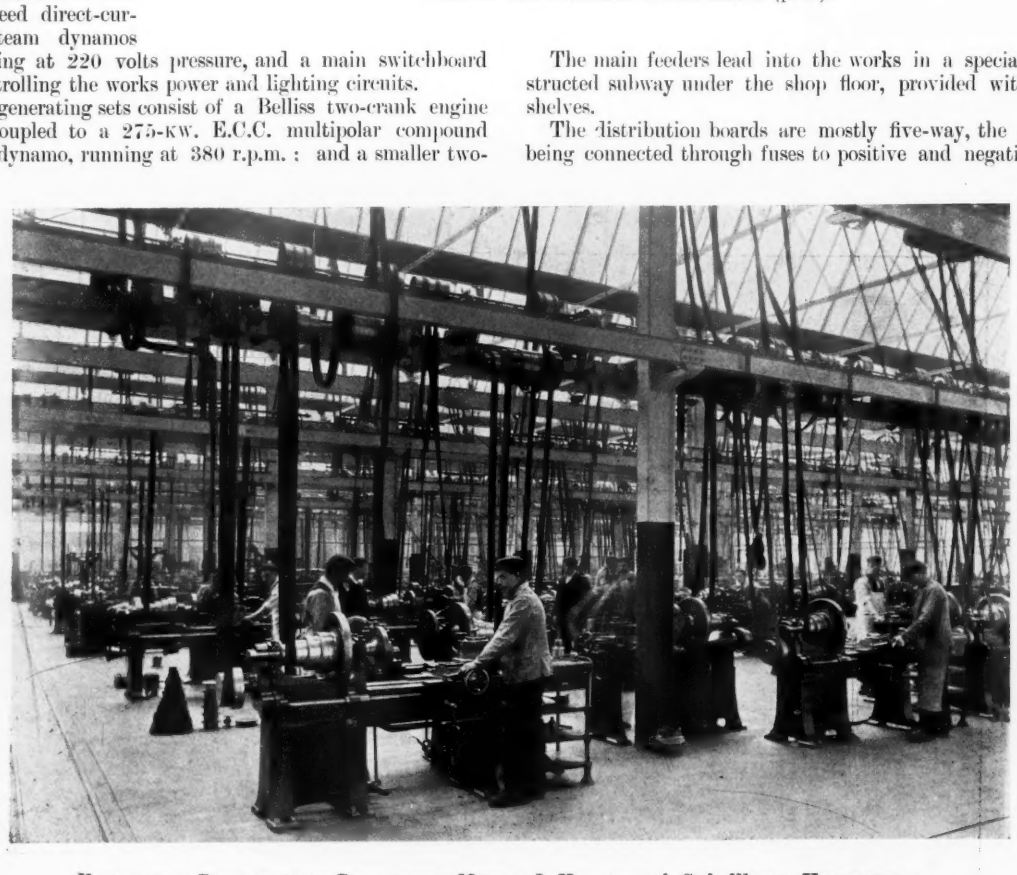
Plan of the Buncrana Power House (p. 21).

The main feeders lead into the works in a specially constructed subway under the shop floor, provided with cable shelves.

The distribution boards are mostly five-way, the circuits being connected through fuses to positive and negative bus-bars mounted on separate slate slabs, and the whole enclosed in teak boxes, with glass doors.

The distributors, which run in steel conduits to the various motors about the works, terminate in each case in a double-pole switch and motor-starter fixed on a teak board in the vicinity of the motor.

The group system of driving has been adopted in the iron



View in the Brass-working Department, Messrs. J. Hopkinson & Co.'s Works, Huddersfield.

and brass departments, where each line of shafting is operated by a slow-speed motor through a chain drive. The driving arrangement is clearly illustrated in the lower view, p. 19.

The motors are of both shunt and compound-wound types,

View of the Buncrana Power Station, showing the Pipe Line.

and include six of 20 H.P., one of 12 H.P., 10 of 10 H.P., and a 5-H.P. motor. They were supplied by various makers.

The lighting feeders run to three distribution boards, fitted with double-pole switches and fuses, and thence to sub-lighting boards, similarly equipped for controlling the various lighting circuits.

Some 160 Jandus enclosed arc lamps, of 1,000 C.P. each, and run two in series, are utilised for lighting purposes, and the offices are fitted up with incandescent lamps.

The latter are arranged to be run from the Corporation's supply by means of a change-over switch, in the event of the works plant being shut down.

The factory hours are arranged on the one-break system, the single interval being from 12.30 to 1.30.

The working week is 52½ hours, but the wages are based on a 54-hour week, the additional 1½ hours wages being given as a bonus to all men who make a full week.

The firm make a point of interesting their men in the work, and in addition to the provision of dining and lecture rooms, they are offering prizes to workmen suggesting improvements appertaining to the business.

ELECTRIC LIGHTING AT BUNCRANA, CO. DONEGAL.

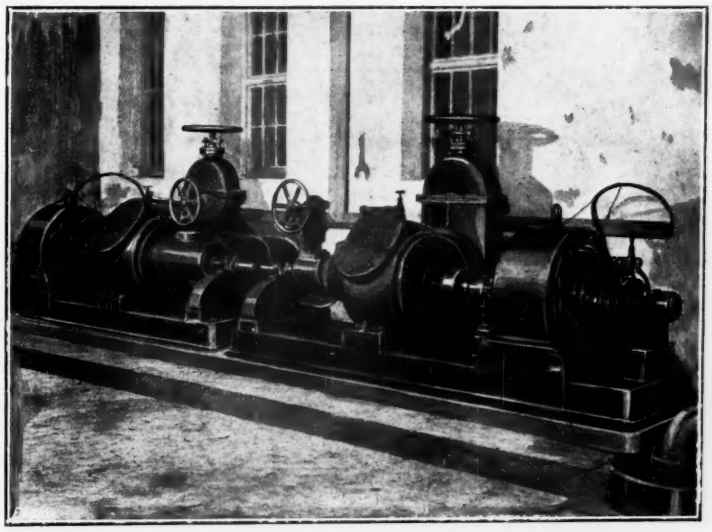
In our issue of October 13th, 1905, we briefly alluded to the inauguration of this scheme for lighting the small village of Buncrana, in Ireland: we are now able to place before our readers some supplementary details of the installation.

The project was the result of local enterprise, and in carrying it out a narrow strip of land lying between an existing water-driven flour mill and the river was utilised as a site for a power house, and various hydraulic works were executed in order to utilise an existing reservoir situated about a ¼ mile above the mill.

The new building, which is solidly constructed in stone, is one storey throughout, although provision is made at one end for an additional floor to accommodate a storage battery. A plan of the building is given on p. 20, and it will be seen that both turbine and gas engine plant are installed, the latter being available in case the water supply should fail.

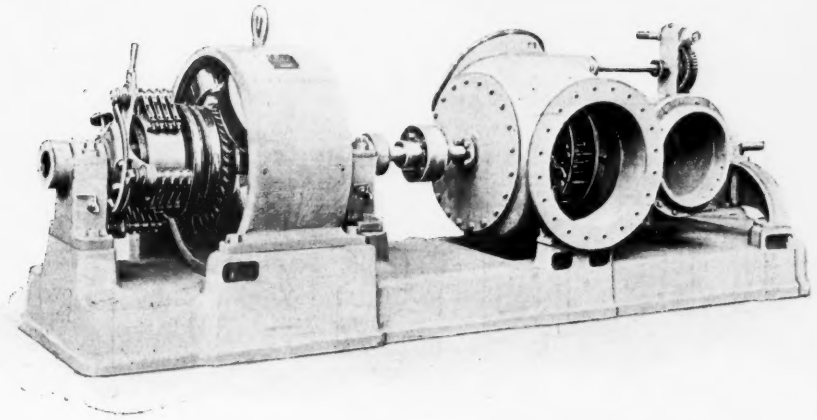
The water supply flows from the storage dam, along a head race constructed on the river bank, to a point about 600 ft. from the power house; the head race terminates in a chamber fitted with a strainer and sluice gates; and a riveted steel pipe line, 28 in. internal diameter, leads to the turbines.

The pipe line is practically all underground, and allows of an available head of 60 ft. at the turbines. Two of the latter are installed, of the latest improved Leffel type: each is capable of developing 60 B.H.P. at a speed of 780 r.p.m., and is connected through an 18-in. sluice valve to the pipe line which terminates just outside the building.



Two 60-B.H.P. Turbo-generators, Buncrana.

The turbines, which we illustrate herewith, are of the "mixed flow" type, fitted with runners 13¼ in. diameter, which revolve within a casing provided with adjustable gun-metal guides, so that steadiness of running and high efficiency are obtainable over a wide range of gate opening.

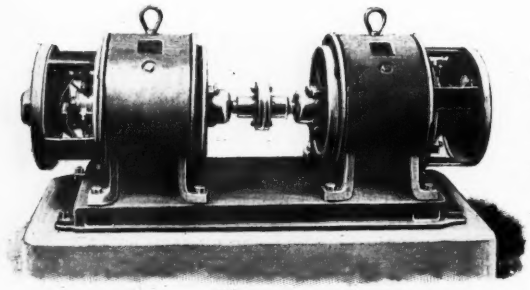


A Single Turbine and Generator Unit, Buncrana.

Steel suction pipes, by which the water is discharged, lead

back to the river, the tail water level being some 12 feet below the turbines.

Each of the latter is direct coupled to a Crompton four-pole shunt-wound generator having an output of 80 amperes at 480 to 500 volts pressure.



Crompton Balancer, Buncrana.

We now come to the gas plant, which is interesting as being the second "suction" plant installed in Ireland.

The engine, which is capable of developing 75 B.H.P. at a speed of 180 r.p.m., is fitted with balanced cranks and magneto ignition with a timing adjustment.

As will be seen from the plan, the engine drives on to a countershaft by means of a pulley fitted with a friction clutch, and from the shaft a belt drive leads back to a 15-KW. enclosed type generator of similar make to the others, and capable of giving 85 amperes at 550 r.p.m., which is situated in proximity to the gas engine.

The countershaft can also be utilised for driving the flour mill adjoining.

The suction producer plant is of the builder's latest type; the generator is fitted with a rocking grate and a feed-water heater for producing the necessary water vapour for gas making. The gas passes through a coke scrubber to the engine, through some 35 ft. of gas main, and we understand that this exceptional arrangement has so far given no trouble. The water for cylinder cooling and for the gas generator is drawn from the river and stored in a tank on the roof, a small rotary pump driven from the engine, being utilised for this purpose.

The arrangement of the electrical plant presents some novel features, as the gas engine dynamo is so connected that it can be operated as a 50-B.H.P. motor from the turbo-generators, for driving the adjacent mill, if desired, through the countershaft, the clutch of the gas engine drive being then withdrawn.

The variation of speed in the motor has been obtained by inserting a shunt regulating switch in the field circuit of that machine.

A balancing set, which is also installed in the engine room, is capable of dealing with an out-of-balance current of 20 amperes on either side of the three-wire system. The machine consists of two four-pole direct-coupled generators, with a speed of 1,500 r.p.m.

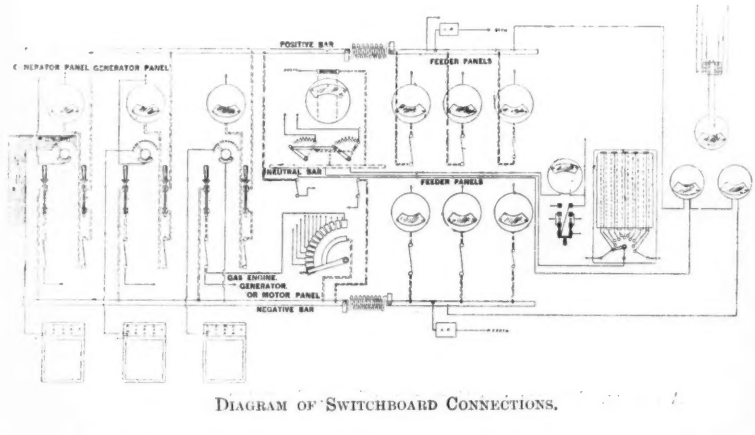


Diagram of Switchboard Connections.

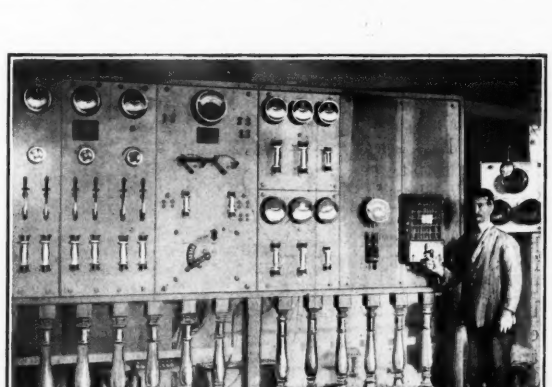
The switchboard, which was supplied by the G.E. Co., Ltd., consists of five polished marble panels; two separate turbo-generator panels are provided, and a third panel controls the generator or motor (as the case may be) installed near the gas engine.

These panels are equipped with single-pole quick-break knife switches, enclosed fuses, field regulating switches, &c.; the third panel is fitted with an additional twelve-way 50-H.P. motor starting switch in parallel with the negative knife switch.

The starting switch is mounted on the lower portion of the central panel, which also contains a double starting switch of similar construction for connecting the two balancer armatures to the neutral bus-bar, and a leakage ammeter.

The feeder panels control four private and two public lighting feeders; each feeder has an ammeter and enclosed fuse in circuit, while both poles are protected by B.T.H. lightning arresters, the distribution being by bare overhead wires. Kicking coils, inserted in the bus-bars between the feeder and generator panels, are also provided for protecting the machines.

A double-pole change-over switch on the right hand of the feeder panels, enables the power house and mill lighting installations to be connected to either side of the system, for balancing purposes. The power house wiring is all carried out in casing, the latter being served with two good coats of compound, where the wires emerge for connection to the overhead system. The distribution mains are carried overhead throughout, on poles spaced about 130 ft. apart, and placed as far as possible out of sight behind the houses. In a few cases of straight runs, the line is placed along the edge of the footpath.



Main Switchboard, Buncrana.

The cables consist of bare copper strand suspended from porcelain oil insulators on the cross arms of the poles; the distributors are 7/15 S.W.G., the neutral mains consist of two No. 10 S.W.G. wires, cross-connected and arranged, in accordance with the B. of T. regulations, on the lowest cross-arm and outside the other conductors, with a view to earthing either of the latter, in case of breakage.

The house services are tapped off the overhead lines at intervals, lead-covered insulated wires being led into the buildings.

The contractors for the whole of the power house installation were Messrs. James Gordon & Co., of London, who also designed and supervised the carrying out of all the constructional and hydraulic work in connection with the scheme; the gas engine and producer plant were supplied by Messrs. William Grice & Sons, Birmingham, as sub-contractors.

Mr. Louis J. Lawless, of Dublin, acted as consulting engineer for the electrical section of the work.

LIGHTING AND POWER NOTES.

(*Concluded from page* 18.)

South America.—Bahia Blanca.—For the following we are indebted to the *Review of the River Plate*:—In view of the numerous fatal accidents that have taken place from defective E.L. installations, the municipality has resolved that the public and private lighting by electricity shall be immediately suspended, and not renewed until the pressure has been changed to 500 volts. Our contemporary states that the whole of the supply company's mains, installations and plant are in a "most deplorable condition."

Todmorden.—The T.C. has reduced the price of energy from 5d. to 3d. per unit.

U.S.A.—San Francisco.—The California Gas and Electric Corporation of Sacramento Valley and the 'Frisco Gas and Electric Co. have united as the Pacific Gas and Electric Co., and propose to distribute power in San Francisco from the Sacramento Valley Falls.

Milwaukee, Wis.—The granting of a licence by the Council to the Municipal E.L. and Power Co. is under consideration. It is proposed to install plant to supply 3,000 2,000-c.p. lamps, at an expenditure of not more than £50,000. The cost per annum for street lighting is estimated at £18 per lamp.

New York.—The City Council has been recommended to erect a generating plant for Brooklyn at a cost approaching £1,800,000. This is part of the scheme to substitute municipal supply for that from the Edison Co., and similar to that decided upon for the borough of Manhattan. The small municipal plant recently erected is now supplying lighting for the Williamsburg Bridge.

Wellingborough.—Representatives of the Northampton E.P. and Traction Co. have waited on the R.D.C. in regard to an application for a prov. order, and have stated that at present, as a nucleus scheme, the company intends to lay mains to Rushden and Higham Ferrers.

West Bromwich.—The E.L. Committee has recommended the T.C. in future, for a demand above 3 h.p. when the consumption does not reach 600 units per quarter, to charge 1½d. per unit, and when it reaches 600 units or above per quarter 1d. per unit. Discounts varying between 2½ per cent. and 10 per cent. should also be allowed consumers of energy for power amounting to between 6,250 and 25,000 units per quarter.

Willesden.—The L.G.B. has sanctioned the borrowing, by the Council, of £20,000, which is to be expended as follows:—Mains, £13,678; services, £1,382; plant and lamps, £3,500; meters and indicators, £1,440. In regard to the resolution adopted in October last to put up 50 additional arc lamps, without increasing the present charge, the U.D.C. has, on the recommendation of the resident engineer, adopted "flame" lamps, and increased the number to 66.

Willington.—A meeting of the ratepayers has been held in the town to protest against the action of the U.D.C. in not supporting an E.L. scheme brought forward by the County of Durham E.P.D. Co.

TRAMWAY AND RAILWAY NOTES.

Belfast.—At the monthly meeting of the City Council on New Year's Day, it was announced that the total cost of the conversion and purchase of the tramway system was £1,052,714, less salvage £40,405, leaving the net cost of the undertaking £1,012,309. Of this sum only £900,000 was borrowed, and from that stamp and other duties amounting to £34,413 had to be deducted. Further borrowing powers were available up to £100,000. The system up to the present has been a decided success.

Birkenhead.—The Corporation has obtained a fiat from the Attorney-General authorising proceedings against the Mersey Railway Co., and has caused a writ to be served on the latter to answer an application which will be made by the Corporation in the Chancery Division to restrain the company from running motor-buses within the borough.

Continental Notes.—Italy.—The Austrian Consul in Genoa reports that, although the Simplon Railway has not yet been completed, nevertheless, a Swiss-Italian Committee has been formed to arrange for the construction of an electric railway over the Splügen. The proposed course is from Chiavenna *viâ* the S. Giacomo Valley to Thusis Chur. The length of this line would be about 99 kilometres, and the cost about £7,000,000.

The Comitate Superiore Delle Strade Ferrate has sanctioned the construction and exploitation of an electric tramway from Villa Salazar-Ponte Chiasse to the Swiss border.

Coventry.—It was with surprise that we gathered from the *Daily Mail* that the T.C. of Coventry had started letting out electric motor-cars on hire, with such success that a large number were about to be added to the stock. It appears, however, that the Corporation, as we have previously stated, lets out *motors*. Sir A. Harmsworth having edited a book on "Motoring," his staff apparently think that all "motors" are motor-*cars*.

Delagoa Bay.—At a meeting of the Delagoa Bay Development Corporation, Ltd., last week, the chairman, in referring to the electric tramways, said that these were at the present time the least satisfactory of the company's various works. Expenses were being gradually reduced, and the directors hoped that before long the receipts would exceed the expenses. The success of the tramways was dependent in a great measure upon the increase of the population of the town, unless other sources of revenue were obtained, such as the sale of power, freight traffic, &c., which they were endeavouring to develop in every possible way. They had to contend with considerable racial prejudices; the whites would not ride with the yellows or the blacks, and these difficulties had to be overcome by running separate cars for each colour, which would mean a tremendous increase in the staff and working expenses. During the year ended June 30th they had carried 721,078 passengers, and run 287,519 miles. The travelling population was carried by the company 120 times in the course of the year, which compared very favourably with most English towns. He regretted, however, that the number of passengers per car-mile was lower than most returns, and this was, of course, the great reason why the tramways did not make progress. At the same time, these two facts taken together—namely, the number of times the population were carried and the number of passengers per car-mile—indicated that the present service was quite sufficient, and was efficiently handling all the work that could be expected in the present state of the port. It also indicated that much could not be expected by an immediate extension of the company's lines. Since April last they had been running seven cars with a 20-minute service. There was every reason to believe that, as the town developed, the receipts of the tramways would rise considerably without increased expenditure or immediate extension, because the track at present covered an enormous quantity of unbuilt-on ground, and naturally the desire would be to build on streets where cars already ran. The freight car traffic was a very promising feature, and would, he thought, steadily increase. The sale of power was also being developed, and should increase as the town improved. In order to assist the directors in arriving at a solution they called in the assistance of Messrs. Mordey and Dawbarn, consulting engineers. Within the past months they had furnished the directors with their preliminary report and advice. A member of their firm was at present in South Africa, and after the directors had received a further report from him, they would determine the best course to follow in order to endeavour to place this service on a better basis. The board had every reason to believe that the working costs for the present year would be considerably reduced. The proportion of expenses to receipts had diminished from 165 per cent. in June, 1904, to 123 per cent. in June, 1905, while in July it was 110 per cent.

Dundee.—The electric tramway between Dundee and Monifieth, which has been constructed in six months, was opened to public traffic on the 27th ult.

Hythe (Kent).—A special meeting of the T.C. was held on Friday "to consider as to applications for consent to tramways and make order thereon." Mr. Sellon wrote stating that he had deposited the £2,500 promised in the local bank in the joint names of the promoters and the Council, and Mr. Cownie, on behalf of the National Electric Construction Co., wrote saying that a sum of £2,000 could be had for the asking as a deposit and guarantee that the syndicate would carry out certain street widenings, &c., when called upon. As usual, the meeting ended without any definite result being arrived at.

London.—Great Northern and City Railway.—In place of the straps which have proved objectionable to passengers who are compelled to stand in the electric trains, the management of the G.N. & City Railway is introducing brass handles fixed on the woodwork. The handles are a great improvement, well worthy of imitation where it is possible.

Metropolitan District Railway.—The company has now completed its system of automatic signalling, and as soon as this is passed by the Board of Trade, it will be possible to increase the train service by 50 per cent.; eventually a two-minute service is to be established.

L.C.C.—On the 28th ult. the B. of T. inspection of the tramway subway of the L.C.C. took place. It is hoped that a sufficient number of cars will have been delivered by the end of January to enable the operation of the line to be commenced.

Rochester.—The Corporation is now taking definite steps towards the commencement of the electric tramways and improvements scheme. The contract to lay one section of the tramway extension from the bottom of Star Hill to Borstal Road (Delce Grange) has been given to Messrs. Dick, Kerr & Co., both for the permanent way and for the overhead equipment.

The Chatham and District Light Railway Co. have announced that they will commence the extension of their line from Jezreel's Tower, Chatham Hill, to Ramham (a distance of eight miles) in March next.

Wallasey.—The Wirral Railway Co. is seeking powers to run motor-buses in the Wallasey district, and has deposited a Bill specifying such powers. The Wallasey District Council, through its clerk, has written to the solicitors to the railway company, asking if they are prepared to agree to a clause similar to that inserted in the North-Eastern Railway Act of 1905, providing that the local authority may prescribe the route to be taken by any railway omnibus between the points of arrival and departure, and that the company shall not run any railway omnibus in any district, otherwise than to or from a station or hotel of the company, without the consent of the local authority.

Wednesbury.—The T.C. has decided to borrow the sum of £17,500 in order to purchase the tramway undertaking in the borough from the South Staffordshire Tramways Co.

TELEGRAPH AND TELEPHONE NOTES.

Durban.—The new municipal telephone system was to be inaugurated on December 11th, by which it is hoped greatly to increase the number of subscribers, who have held back whilst awaiting the new system. There will be a reduction in the cost of connection, which now stands at an average price of £12 per annum.

German Submarine Cables.—The recent completion of German-Dutch cables in the Far East has been followed by the publication of particulars in reference to the development of the submarine cables of Germany since the year 1871. It is asserted that Germany now possesses one-fifteenth of the total length of submarine cables in the world, as compared with the ownership of only 1-26th of the mileage about two years ago. The number of German cables which exceed 100 kilometres (62 miles) in length at present amounts to 13, of which the following is a list, giving the year of establishment and length in kilometres.

Location of submarine cables.	Year established.	Length in kilometres.
1. Emden, Borkum and Lowestoft	1871	421
2. Hoyer, Westerland and Arendel (Norway)...	1879	472
3. Emden and Valencia (Ireland)	1882	1,585
4. Emden, Borkum and Vigo (Spain)	1894-6	2,099
5. Sassnitz and Trelleborg (Sweden)	1898	117
6. Emden, Borkum, Horta and New York ...	1900	7,709
7. Tsintau and Chifu (China)	1900	457
8. Tsintau and Shanghai (China)	1900	702
9. Emden, Borkum and Boston (England) ...	1901	465
10. Emden, Borkum, Horta and New York ...	1903-4	7,905
11. Constanza (Roumania) and Constantinople	1905	343
12. Menaas, Yap and Guam	1905	3,249
13. Shanghai and Yap	1905	3,588
Total length in kilometres		29,112

It will be seen that the total length of the cables reaches 29,112 kilometres, or, say, 18,049 miles. Cables Nos. 3 and 9 belong jointly to Germany and England; No. 5 is the property in common of Germany and Sweden; Nos. 4, 6 and 10 are owned by the German Atlantic Telegraph Co.; No. 11 belongs to the East European Telegraph Co., and Nos. 12 and 13 to the German-Dutch Telegraph Co.; while the remainder represents national cables of the German Government. It should be noted that the Emden-Valencia cable, which is not working now, served exclusively for telegraphic communication with America, but was discontinued when the German Atlantic cables were brought into operation.

The above list of long submarine cables is amplified by a number of short cables which partly connect together localities on the German coast line, and partly serve as a means of communication between Germany and neighbouring countries, as, for instance, Denmark, Sweden and Switzerland. Thus a cable 83 kilometres in length was laid between Arkona and Trelleborg as far back as 1865. In addition to these, there are three African cables which are rented from the English owners on the payment of an annual charge. These are the Zanzibar-Bagamoyo—Dar-es-Salaam cable, which is 136 kilometres long, and the Swakopmund-Mossamedes cable, both of which belong to the Eastern and South African Telegraph Co. The third, which is owned by the African Direct Telegraph Co., is located off the Cameroons, and connects Bonny to Duala, a distance of 337 kilometres.

The recent laying of cables in the Far East, which the Germans claim as a brilliant success for the makers and layers of the cables, has so frequently been referred to that it is now only necessary to mention the depths which were encountered. It is stated that the American Pacific cable in places was laid in 1903 at a depth of nearly four miles, but this record was beaten by the Menado-Yap-Guam cable, which was laid by the *Stephan* in the Spring of 1905 in depths reaching over 4¼ miles. The Shanghai-Yap cable offered even greater difficulties, the depth in the vicinity of the Liukiu Islands being 4·96 miles. The successful completion of these cables is regarded in Germany as showing that the cable-makers in that country are no longer behind the best of the cable manufacturers in Great Britain.

Glasgow.—The daily Press reports that the underground cable between London and Glasgow has now been completed, and was brought into use on Saturday last. This report is, however, incorrect.

Post Office Telegraphs.—A number of changes have been made in the telegraphic signal code to facilitate the use of the Murray-Creed type-printing telegraph system, which is now undergoing practical trials under commercial conditions in the hands of the Department.

Persia.—Construction operations have begun at Karachi in connection with the Indian extension of the Central Persian telegraph line, which will proceed to Panjgur by way of Bela, a distance of over 300 miles, and eventually will connect with the Indo-European Telegraph Co.'s system at Teheran.

Russia.—Telegraphic troubles are still being experienced in Russia.

Street barricades have been erected composed of telegraph posts, &c., bound together with wire, and troops and the police have been authorised to shoot anyone found interfering with the telegraphs and telephones.

Telegraphic and telephonic communication between St. Petersburg and Moscow is still interrupted.

The electric light supply was resumed in Moscow on December 29th, according to a Reuter dispatch.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901 ..	..
Dominica-Martinique	May 7, 1902 ..	..
St. Lucia-Martinique	May 7, 1902 ..	..
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902 ..	..
Cayenne-Pinheiro	Aug. 13, 1902 ..	..
Closed { Vladivostock-Nagasaki	Feb. 7, 1904 ..	..
Closed { Port Arthur-Chifu	Mar. 7, 1904 ..	..
Jamaica-Colon	Jan. 5, 1905 ..	..
Cadiz-Tenerif	July 20, 1905 ..	..
Tarifa-Tangier	Jan. 18, 1904 ..	..
Puerto Plata-Martinique	Oct. 30, 1905 ..	..
St. Thomas-St. Kitts	Dec. 28, 1905 ..	..
Manila-Iloilo	Dec. 28, 1905 ..	..
Landlines.		
Puerto-Barrios	Aug. 28, 1902 ..	..
Kertch-Soutehoum	Sept. 27, 1904 ..	..
Communication with Brazil *via* Galveston	July 18, 1905 ..	..
Indo lines	Dec. 26, 1905 ..	Dec. 26

Turkey.—The Ottoman Administration has officially notified the Bureau International at Berne of the opening of two new telegraph routes between Turkey in Europe, and Bulgaria, the one *viâ* Barakovo, and the other *viâ* Dévé-Baghirdan.

Venezuela.—The *Herald*, New York, publishes a Caracas telegram, saying:—"The *Constitucional* declares the French Cable Co. refuses to pay the municipal tax necessitated by the annulment of its contract. The time for payment has been extended till the middle of January. In the event of the closing of the cable, the Government is preparing steamships to carry cablegrams between Mercuro and Trinidad for transmission by the English cable."

Wireless Telegraphy.—A series of wireless telegraphic experiments took place between the battleship *Hindustan*, during the recent passage home of the Atlantic Fleet, and the cruiser *Drake*, flagship of the Second Cruiser Squadron, stationed at Gibraltar. Messages were received by the *Drake* at a distance of 230 miles, which is a record in wireless telegraphy west of Gibraltar.

According to the *Daily Express*, the Hamburg-American line has concluded contracts for the installation of the Marconi wireless telegraphic apparatus on board all its ocean-going liners.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—January 6th. Six tramcar top-deck covers for the Corporation. See "Official Notices" December 29th.

Belgium.—January 13th. The municipal authorities of Foret (province of Liége) are inviting tenders until the 13th inst. for the concession for the supply of electrical energy for lighting and power purposes in the little towns of Foret, Chaudfontaine and Telff, during a period of 22 years. Particulars may be obtained from, and tenders are to be sent to, Le Bourgmestre de Foret (Liége).

Croydon.—January 9th. The Guardians are inviting tenders for electric fire alarms at the Infirmary. Specifications, &c., from Mr. Henry Berney, architect, 104, George Street, Croydon (deposit, £3 3s.).

Marylebone.—January 10th. House service fuse boxes, also stores, for the Borough Council. See two "Official Notices" December 22nd.

Plymouth.—January 24th. Stores for the Corporation electricity department.

Pontypridd.—January 15th. Eight double-deck tramcars for the U.D.C. See "Official Notices" December 22nd.

Pretoria.—April 6th. Refuse destructor to treat 60 tons of refuse per diem for the Municipality. Mosenthal, Sons and Co., 72, Basinghall Street, E.C.

Rosario.—April 16th. The municipality asks for tenders for the public lighting of the City.

St. Pancras.—January 9th. Arc lamps, columns and cradles for the B.C. See "Official Notices" December 22nd.

Shanghai.—January 12th. Single-phase alternating current energy meters for the Municipal Council. See "Official Notices" to-day.

Southend-on-Sea.—January 25th. One 500-KW. steam dynamo for the Corporation. See "Official Notices" December 22nd.

CLOSED.

Belgium.—The Cockerill Co., of Seraing, has secured a contract for a 3,000-H.P. Parsons steam turbine and Brown-Boveri dynamo for the steel works of M. G. Boel, at La Louvière.

Bristol.—The City Council on Monday confirmed a recommendation of their Health Committee, who reported that arrangements had been made with the D.P. Battery Co., Ltd., for the maintenance and repair of the battery used for the electric lighting at Ham Green Infectious Diseases Hospital, for a term of ten years, at £30 per annum. The Electrical Committee, at the same meeting, reported that they had entered into a number of important contracts. The list is appended:—

Siemens Bros. & Co., Ltd., switchgear, Temple Back	£4,818
Key Engineering Co., arc switchboard, Temple Back	254
Bruce Peebles & Co., Ltd., motor-generators	3,418
Willans & Robinson, Ltd., E.H.T. turbo-alternator	12,100
Siemens Bros. & Co., Ltd., H.T. switchgear, Avonbank	3,217
Siemens Bros. & Co., Ltd., E.H.T. switchgear, Avonbank and Temple Back	6,071
F. Chown, machinery foundations, Avonbank	680
J. Lysaght, Ltd., boiler and pipe gangways, Avonbank	131
Strachan & Henshaw, Ltd., switchboard gallery, Avonbank	388
A. J. Colborne, motor-generator room, Temple Back	776
British Westinghouse Co., Ltd., motor-generators	1,945
British Electric Transformer Co., Ltd., transformers	1,158
Lonsdale Bros., Ltd., boiler and pipe covering, Avonbank	239
Siemens Bros. & Co., Ltd., E.H.T. and L.T. sub-station switchgear ..	1,279
E. Nuttall & Co., construction of sub-station, Cumberland Road ..	4,395

Durban.—The E.L. Committee recently recommended the acceptance of the tender of the Reason Manufacturing Co. for 50 fuses, at 21s. each, through the London agents, and 50 from the local firm of Messrs. Hubert Davies & Spain, of Verity's fuses, at 22s. each. Six tenders were also submitted for 3,200 yards of 19/16 H.T. c.c. cable, and 3,370 yards of ·2 sq. in. single cable. The acceptance of the lowest tender, that of the Henley's Cable Co., at £555 and £655 respectively, was approved of.

Glasgow.—The Corporation has decided to install three further turbo-generators of 3,000-KW. each, and the complete contract, including turbines, alternators (two of which are of Dick, Kerr & Co.'s make, whilst the third is to be of the Westinghouse Co.'s make), together with condensing plant, has been placed in the hands of Messrs. Willans & Robinson, Ltd., of Rugby, who will manufacture the turbines and condensers themselves. Two of these turbine sets are intended for installing in the St. Andrew's Cross station, whilst the third will be installed in the Port Dundas station.

Leyton.—Thermit, Ltd., have secured the contract for the welding and cross bonding of about 18 miles single track in connection with the electrification of the U.D.C. tramways.

New Zealand.—WELLINGTON.—The City Council has received the following tenders, in connection with the Melrose tramway extensions, for overhead work and feeders:—

J. M'Lellan ..	(accepted)	£6,738
Birks & Taylor		6,915
Noyes Bros.		8,918

Wimbledon.—The T.C. has provisionally accepted the following tenders:—

Telephone cables and pilot wires, Johnson & Phillips, Ltd., £586 6s.
Two-ton overhead crane and steel joists, and crane rails for generating station, Herbert Morris & Bastert, Ltd., £42 12s.
Electrically-driven plant for Raynes Park pumping station, Brush Electrical Engineering Co., Ltd., £407.

Handy Medical Battery.—An extremely neat little contrivance has reached us from Messrs. Huggett & Worthington, of 30, Sankey Street, Warrington, in the shape of a pocket primary battery and induction coil. The apparatus is designed so that the act of holding it in one hand switches on the current, and a little regulator provides for varying the intensity of the interrupted secondary current—which, we believe, medical electricians call "faradic"—a very necessary accessory, for when full on the shocking powers of the instrument are, to say the least, severe! We admit that we were more than surprised when we first tested its powers. A convex metal disk and a round massage ball are fixed to the front and top of the case, and the mode of use is to hold the device in one hand, while applying the disk or ball to the body; or in the bath, the disk can be applied to the tap or the plug chain, It is stated that the battery will last about 350 days, at the rate of five minutes per day, and can readily be renewed when exhausted. It is certainly clever; as to its therapeutic merits, we can say nothing beyond the fact that it is a genuine (and powerful) source of faradic currents.

FORTHCOMING EVENTS.

Saturday, January 6th.—At 3 p.m. Association of Engineers-in-Charge. Visit to inspect plant and batteries at the Courts of Justice for lighting the building.
Thursday, January 11th.—At 8 p.m. I.E.E. Conclusion of Discussion on Mr W. H. Patchell's paper on "The Charing Cross Co.'s Bow Works."
Friday, January 12th.—At 7.30 p.m. I.E.E. (Manchester Students). Mr. J. C. Ward on "The Electrical Equipment of Automobiles."
At 8 p.m. I.C.E. (Students). "The Theory of Machines" by Prof. J. D. Cormack.
Saturday, January 13th.—At 7 p.m. Association of Engineers-in-Charge. Social evening.
Tuesday, January 16th.—At 7.30 p.m. I.E.E. (Manchester). Mr. W. C. Mountain on "Electric Winding as applied to Main Shafts, considered Practically and Commercially."
Wednesday, January 17th.—At 7.30 p.m. I.E.E. (Birmingham). Meeting.
Thursday, January 18th.—Rugby Engineering Society. Mr. F. J. Sharr on "The Design of a Large Shop for Electrical Manufacturing."
Friday, January 19th.—At 8 p.m. I.M.E. Meeting (Election of Officers).
At 9 p.m. Royal Institution. Prof. J. J. Thomson on "Some Applications of the Theory of Electric Discharge to Spectroscopy."
N.E. Coast Institution of Engineers and Shipbuilders. Meeting.
Saturday, January 20th.—At 7.30. Glasgow and West of Scotland Technical College Scientific Society. Mr. J. Hogg on "Deep Mine Pumping."

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

THE following orders are issued:—

Monday, January 8th.—"A" Company, technical instruction, 7 p.m.
Tuesday, January 9th.—"B" Company, technical instruction, 7 p.m.; medical inspection, recruits, 7 p.m.
Thursday, January 11th.—"C" Company, technical instruction, 7 p.m.
Friday, January 12th.—"D" Company, recruits' infantry drill, 6 p.m.; technical instruction, 7 p.m.
Saturday, January 13th.—Week-end instruction (whole day) for "D" company "D" company supper at 7 p.m.

J. H. S. PHILLIPS, Captain E.E.
For O.C.E.E.R.E. (V.).

NOTES.

New Rand Power Scheme.—Reuter reports from Johannesburg that a scheme is under consideration for the installation of an electric generating station at Vereeniging capable of developing 100,000 H.P. for supplying the needs of the Witwatersrand. Vereeniging is 32 miles in a straight line from the Rand, and it is intended to utilise the coalfields in the Vereeniging district, where a plentiful supply of water is also available. The promoters of the scheme contemplate the provision of electricity for power purposes and for the supply of light and heat to the whole reef, including Johannesburg and the neighbouring towns. They anticipate that the scheme will enable large economies to be effected in capital expenditure on the various mines and in the working costs.

Fatality.—On Friday last a young electrician named Cullingworth, while employed by Messrs. Fowler & Co., of Hunslet, in laying cables, was fatally crushed between a travelling crane and a column.

Gas.—A serious gas explosion occurred at a Paris florists' on Thursday last week, and did damage to the tune of £1,000, injuring several people.

At Grimsby on 21st ult., the office at a brass foundry was wrecked by a gas explosion. Two men were badly burned.

The Electrical Chess Club.—We are informed that the membership of the Electrical Chess Club is increasing satisfactorily. A number of matches and tournaments have been arranged, and the club should have a successful season. Meetings are held on Thursday evenings at Carr's Restaurant, Strand. The club is open to all connected with the electrical industry. Applications for membership should be addressed to the hon. secretary, Donington House, Norfolk Street, Strand, W.C. The subscription is 5s. per annum.

Falkirk and District Tramways.—ADDENDUM.—The cables used in connection with this scheme were the St. Helens Cable Co.'s vulcanised Dialite bitumen variety, laid solid in wood troughing; similar cables, but lead-covered, were laid under the canal.

Correction.—In our second leader last week, in the third line from the end of the second column on p. 1038, an error occurred. The line should run:—"This is merely 'Little England,' Ease of acquisition," &c.

Institution and Lecture Notes.—I.E.E. Manchester Students' Section.—A meeting of the Section was held on December 8th last, when a paper was read on "The Electrification of Existing Steam Railways" by Mr. W. H. M. Parr. The author said the problem of rapid transit had been solved by the electrification of railways. Electrically-propelled trains could run faster for a given cost of coal than steam locomotives, and did not consume coal when standing in a station or siding; also cheaper coal could be burnt at the central stations. They also saved a considerable amount in repairs to permanent way. Short trains at short intervals ran in less time due to the saving of time at stations, the boarding and alighting of passengers being less congested. As regards system of working, he thought the D.C. third rail system was the best at present; A.C. systems were better for long distances. The terminal efficiency of stations was increased, due to the fact that trains could be driven from either end, and this did away with much shunting and turning. He thought that regenerative control would effect a saving of about 30 per cent. and reduce the wear and tear on brake blocks considerably.

Before the Derby Society of Engineers recently a paper was read by Mr. H. T. H. Edgecombe on "The Electrical Storage Battery."

Before the Coventry Engineering Society recently Mr. A. W. Farnsworth read a paper on "The Estimation of Costs."

Last month, Count Arco, technical director of the Gesellschaft für Drahtlose Telegraphie, gave a lecture on "Novelties in Wireless Telegraphy," in Berlin. He began by demonstrating the closed oscillation circuit formed by spark gap, self-induction and Leyden jars, and then showed how the closed oscillation circuit theoretically could be turned into an open one, and how a closed circuit and open one could be coupled, so that the former acted as a reservoir of energy, the latter sending it out. The transmission between both circuits took place only when they were in resonance. The lecturer demonstrated the practical value of tuning by a striking experiment. Two sets of six apparatus of the small demonstration type were placed side by side each provided with a small aerial of the same length, several feet. One group was used for transmitting, and one for receiving, and always one apparatus of the first group was tuned to one of the latter. The wave-length of each pair differed from the next only by about 25 per cent. The tappers of the receiving instruments were replaced by electric bells of different tones, those belonging to an apparatus with a deeper electric tone giving a deeper bell tone also. Although the apparatus of both the transmitting and the receiving groups were as near to each other as practically possible, each transmitter affected only the corresponding receiver. Several of them even worked together at the same time, and each receiving instrument selected the waves meant for itself. A military wireless outfit was shown, in which the aerial consisted of a magnalium tube, not longer than 6 ft. when packed up, but about 50 ft. high when in operation, and then covering an area of about 20 miles radius over-land. The lecturer attributed the rapid development of his firm to the constant "measuring" interest they had taken in the wireless phenomena and the practical construction of every detail of apparatus and machinery. Certainly the success attained by Count Arco and his company does great credit to him and his fellow workers.

Charge of Theft.—The *Daily Mail* says that by request of the British Government a man named Michael Charles Manby has been arrested at Lisbon on a charge of theft. Representing himself as a director of the British Westinghouse Manufacturing Co., of Manchester, he entered into important negotiations with the Portuguese Government, and by false pretences obtained large sums of money.

The Milan Exhibition, 1906.—We are pleased to learn from the secretary of the National Electrical Manufacturers' Association (Incorporated) that it has come to an arrangement for its members to make a collective exhibit of electrical appliances, &c., at this exhibition.

Rotary Converters in connection with Buffer Batteries.—The widespread use of rotary converters on American electric railways may be put down to the tendency to reduce first cost and loans to a minimum by feeding a very long stretch of line from a single large generating station. This involves high tension transmission, which can only be economically carried out with alternating currents. The H.T. supply (usually three-phase) is then converted by means of transformers and rotary converters into low tension direct current at numerous sub-stations along the line. With this arrangement (except in the case of very dense traffic, where a certain equalisation exists) excessive power and voltage fluctuations are liable to occur. The voltage fluctuation can be partially prevented by compound-winding the rotaries and inserting reactance in the low tension three-phase lines, but this does not avoid violent load variations. In order to prevent these variations throwing the rotaries out of step, it is found necessary to provide damping circuits on the magnets, and these may cause a considerable loss of energy.

These objections disappear if buffer batteries are used in parallel with the rotary converters, and although these are at present seldom used in America, provision is made in most new installations for their future introduction.

As is well known, the buffer action of a battery depends on its low internal resistance and consequent low voltage drop with increasing current, and for effective action, supposing boosters or other special devices are avoided, the dynamo working in parallel with the battery must have a relatively large voltage drop. In the case of a rotary converter the direct current voltage curve depends on the constancy or otherwise of the alternating current supply, so that under ordinary conditions a rotary is not suitable for use with a buffer battery. If, however, a differential booster is used in series with the battery across the mains, this difficulty is removed.

In the arrangement adopted by Messrs. Siemens & Halske on the Remschied tramway line, the booster is excited by the differential action of a shunt winding connected across the battery, and a series winding carrying the external current. The two excitations are adjusted so that with normal external load the booster gives no volts and the battery neither takes nor gives current. As the external load increases or falls from the normal, the series or the shunt winding becomes the stronger, and the booster either adds or subtracts volts from the battery, thus causing it to discharge or to become charged to the necessary extent to maintain a practically constant load on the rotary converter.

If required, the booster can be directly coupled to the rotary converter, and the separate driving motor can thus be dispensed with.

If the booster is omitted and plain parallel connection of battery and rotary converter is desired, the necessary drop in the direct current voltage of the rotary could, of course, be obtained by producing a drop in the alternating terminal voltage by increasing the resistances of the transformer secondaries. This method would, however, not prove satisfactory, both on account of the heating and because the amount of the voltage drop must be capable of adjustment during the day in order to suit the variations of the "average load," which depends on the traffic and varies from hour to hour.

In the ordinary direct current station with a shunt dynamo in parallel with a battery, this adjustment is carried out by regulating the resistance in the dynamo shunt by hand.

The equivalent of this could be obtained in the case of the rotary converter by the use of a set of three adjustable resistances arranged in series with the secondaries of the transformers. The same effect could also be produced with choking coils in place of resistances, but would probably prove less convenient because the wattless currents so introduced would tend to overheat the armature, and also because a simple resistance switch is easier to handle than the adjustable core of a choking coil. At the same time the resistances would only be economically applicable in cases where the regulation required was small.

It would be as well to interlock the resistance switch with the field regulating switch of the rotary converter, so that at every load the field strength may be the correct one corresponding to practically unity power factor.—B. Jakobi, in the *E.T.Z.*

Manchester Corporation and the Midwood Case.—No Appeal.—At a meeting of the Manchester Corporation on Wednesday, this matter was considered. Counsels' opinion had been taken, and it read as follows:—

"We have carefully considered the judgment in this case delivered in the Court of Appeal. There is some doubt as to whether the judgment of Lord Justice Romer is accurately reported, but whether this be so or not, the judgment of the Court upon the construction of Sec. 70 of the provisional order is one which throws very heavy responsibility upon the Corporation in respect both of its electric lighting and gas undertakings. The effect of this construction of the clause is, in substance, to make the Corporation insurers of all the property liable to be affected by any derangement, however caused, in the working of their system. We do not think that this was the intention of the Legislature; but whether it was or not, it seems to us of vital importance that the opinion should be taken of the highest Court, with a view, if necessary, to further legislation, defining the liabilities of corporations and statutable bodies for putting those liabilities on a more reasonable footing. The judgment in this case, as it stands, would make the Corporation liable to an unlimited extent in damages where accident occurs, even although the damage may be the result of inevitable accident or of the intervention of persons over whom the Corporation has no control. Such a liability has never hitherto been imposed on any public undertaking. . . . The question of negligence in the present case was not considered on its merits by the Court of Appeal. . . . The important consideration for the Corporation is that by the present judgment it is subjected to liabilities which have never, as yet, been borne by those responsible for public undertakings . . . . . We advise, therefore, that the case is one in which, in our opinion, the present decision should be challenged by an appeal to the House of Lords, and, furthermore, it is one which raises in a precise and particularly available form, the exact points upon which it is important that a final decision should be had.

"(Signed) J. Fletcher Moulton,
"Alex. Macmorran,
"J. W. Gordon."

The Manchester Corporation Committee recommended against an appeal to the House of Lords.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—Mr. R. Chadwick has resigned the position of switchboard attendant at the Wrexham

Corporation Electricity Works, he having received an appointment at Rugby with the British Thomson-Houston Co.

Mr. ERNEST A. POOLE, resident engineer of the Cleveland and Durham County Electric Power Co., has obtained an appointment under the South American Light and Power Co., and sailed on Friday last, December 29th, for Bahia Blanca. Before leaving, he was presented with a slide rule and book subscribed to by the whole of the staff at the Bishop Auckland power station.

The Te Aroha (N.Z.) Council has appointed Mr. A. T. CROSHER as electrical engineer. There were 17 applicants.

Mr. C. S. VESEY BROWN is retiring from the position of engineer and general manager to the Northern Counties Electricity Supply Co., and is starting an office in Milburn House, Newcastle-on-Tyne, for the purpose of practising as a consulting electrical engineer, in all branches of electrical power and lighting, and with particular reference to the design of distribution systems for local authorities and others who purchase a supply of energy "in bulk."

A recommendation that the salary of the assistant borough electrical engineer at Bridlington (Mr. D. H. SIMPSON) be raised from £100 by annual increments of £10 to £130, also that the salary of the clerk (Mr. T. E. MOTT) be advanced from £75 by annual increments of £7 10s. to £90, has enabled the Bridlington Councillors to give an exhibition of their littleness. Both men, according to their Committee, were capable and deserving. It was stated that Mr. Simpson had put in over 100 hours per week at the works, that he might be difficult to replace, and that the staff was insufficient. The Mayor, too, complimented the Committee and staff upon the efficient manner in which a recent breakdown had been coped with. These facts notwithstanding, the majority voted against the increases, an amendment referring the matter back being carried by 13 votes to 9. The opposing parties muttered about economy, and then went off on another track, grumbling because the men were about the works so much, and suggesting that there ought to be additional labour engaged; by being over-worked they imperilled the safety of an expensive building and plant, and so on. The men, therefore, who are admittedly capable, and have worked remarkably long hours in the interests of the undertaking, are to be rewarded with a rebuff! Perhaps more men will be engaged, the expenses of the department will be larger, and there will be more to ask for small advances. Truly a position under the Bridlington Borough Council is not an enviable one. We do not know what sort of men these little Bridlingtonians are who voted in the majority, but doubtless they are of that "labouring" class who believe in cutting the salary of the technical and qualified official because they fail to appreciate the value of technical qualifications. A bricklayer they know, a carpenter they know, even a grocer's or butcher's worth they know—but an electrical engineer—Heaven help him when they have to estimate his value. True municipal economy is to be applauded, but it is too often the way of the municipal councillor to embark recklessly upon ambitious schemes, and then, with a pretence at economy, to flout those upon whom they depend for their successful fruition. We do not hesitate to say that the Bridlington policy as here outlined is one of false economy, while it is also devoid of all justice.

On December 29th a smoking concert was held at the Ealing electricity works. The chair was taken by Mr. J. DOUGLAS KNIGHT, borough electrical engineer, who a short time ago called together the staff and employés, and suggested the formation of a band, with the idea of bringing them all into more intimate social relations with himself and one another, thus tending to promote good feeling and harmonious working together for the good of the electricity undertaking. A committee consisting of Messrs. J. Douglas Knight, E. J. Foster and C. W. Gordon, was appointed to manage the financial interests of the band, Mr. G. Watts acting as hon. secretary, and they procured the music for the various instruments, and then a piano. Mr. F. Moore was elected leader of the band, and he and Mr. Money have devoted most of their spare time to bringing on the less advanced performers. Mr. Knight, in opening the concert, referred to the work of the staff in assisting to make the electricity undertaking a success, and said that, being a man of few words, he perhaps did not always say quite as much on that subject as he might do; still, he could assure them that no one recognised and appreciated the good work done by his staff more than he did, and he was very glad of this opportunity of telling them so, and he hoped that the entertainments they would have, and of which this was the first, would conduce to a better understanding and kindlier feeling amongst them all. At the conclusion of an excellent and varied programme, Mr. Knight moved a hearty vote of thanks to the band and all who had assisted, and said that, successful as this, their first concert, had been, he was sure that it was only a foretaste of the good things in store for them now that they had got their musical talent on an organised footing.

Tramway Officials.—On Thursday evening last week Mr. LEONARD JOHNSTON, a joint manager of the Blackburn Corporation Tramways Department, entertained the staff of the department to supper at the Crown Hotel. Advantage was taken of the occasion to present him with a spirit frame. After a little appropriate speech-making, in which Alderman Thompson said complimentary things of Mr. Johnston, and Mr. Johnston replied, a smoking concert was held.

Mr. WALTER H. TITTENSOR, M.I.E.E., engineer and manager, of the Preston Corporation Tramways, has declined the offer of the Council to extend his engagement until May 1st, having accepted the post of Scottish manager for Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne, with headquarters at 19, Waterloo Street, Glasgow, where he will take up his new duties on February 1st, 1906. The Council have unanimously appointed Mr. J. F. SIMPSON, who has acted as chief assistant, to succeed Mr. Tittensor as borough electrical engineer and tramways manager, at a salary of £300 per annum.

The second annual dinner of the employés of the Tyneside Tramways and Tramroads Co. was held on Tuesday, December 26th, Mr. McClelland presiding. After supper Mr. HANKS, who is leaving the company to take up a position with the Westinghouse Co., was presented, on behalf of the staff, with a travelling bag and dressing-case.

General. — The drawing-office staff of the British Thomson-Houston Co., at Rugby, have presented a microscope in case, and an illuminated address on silk, to Mr. W. R. WATSON, chief draughtsman, who is leaving: while Mr. E. J. ALLISSTONE, of the accountants' department, who is also leaving Rugby, has been presented with a marble clock.

Mr. H. E. BRAIN, the electrical engineer to the Buenos Ayres and Pacific Railway, sailed for Buenos Ayres on 29th ult. in the Royal Mail Steamship Co.'s ss. *Clyde*. Mr. Brain has spent the the past few months in England arranging for the supply to the Buenos Ayres and Pacific Railway Co. of a large amount of electrical generating plant and motors for use at Bahia Blanca, Caseros and Junin. Part of this is already *en route*, and delivery of the balance will soon be accomplished.

At a meeting of the British Fire Prevention Committee on December 20th, Mr. W. NOBLE TWELVETREES, M.I.M.E., A.M.I.E.E., was elected a member of the Executive *vice* Mr. Lionel J. Langridge, A.M.I.E.E., and was at the same time nominated to serve on the General Testing Arrangements (Standing) Sub-committee.

Mr. MARSHALL H. BENNETT, A.M.I.M.E., A.M.I.E.E., has resigned his position with the British Thomson-Houston Co., Ltd., and will enter into partnership with Thomas L. Scott & Co., contracting engineers, of 3, London Wall Buildings, E.C. It will be remembered that Mr. T. Laidlaw Scott was, until recently, engineering director of Macartney, McElroy & Co., Ltd.

Mr. W. KNIGHT, who has just taken up his duties as chief clerk in the Complaints Department of the St. Marylebone Electricity Department, was on Monday, 1st inst., presented with a dressing-case by his late colleagues of the Woolwich Council Electricity Department.

Obituary.—We regret having to announce the death of Mr. JOHN DILLWYN SIMS, a member of the firm of Ransomes, Sims and Jeffries, Ltd., of Ipswich, who died at his residence, on December 30th, and was interred on 2nd inst. at the Ipswich Cemetery.

We regret to record the death, which occurred on December 21st, of Mr. HENRY JOHN YOUNG, who was a past chairman of the Junior Institution of Engineers, and had been a member from 1888.

Mr. CHARLES T. YERKES died on the afternoon of December 29th, at the Waldorf Astoria Hotel, New York, where he had been ill ever since his arrival there from London early in November. He was born in Philadelphia in 1837, and was 68 years of age. Bright's disease is said to have been the cause of death. Mr. Yerkes from his early days was a hard-headed, shrewd and bold money-maker, with remarkable powers of organisation which ensured the success of his well-deliberated schemes. His connection with electrical matters in America resulted from his securing control of a Philadelphia street railway when he was only 23, for he then obtained that experience in street railway organisation and management which stood him in such good stead when he, years later, made Chicago the scene of his labours, a city where he eventually succeeded in providing large facilities for cheap transit. When he considered his work accomplished at Chicago, he turned his attention to London, more especially to its underground railways, at a time when the electrification of these lines was sadly needed. The facts that these lines are now electrified, and that certain new electric tube railways are at this moment constructing, are due primarily to the action and influence of Mr. Yerkes and his financial circle. It will be remembered that he gave evidence at the celebrated Metropolitan and District electrification arbitration conducted by the Board of Trade, and that he has given evidence at other Parliamentary inquiries relating to London electric railway projects. He was successful in amassing an enormous fortune, but he generously contributed from his abundance to scientific research. He seems to have been of a cool and unperturbed disposition at times of grave anxiety, when other men were at fever-heat excitement, and this important characteristic is doubtless—together with the great simplicity of his manner of life—responsible for his reaching his sixty-eighth year, instead of his career being prematurely cut short as is the case with so many men of enormous speculative ventures. We read that arrangements have been made by Messrs. Speyer & Co., for the completion of the various works upon which Mr. Yerkes was still interested at the time of his death. The new managing director of both the Underground Electric Railways of London and the Metropolitan District Railway will be Sir George Gibb, who has now resigned the general managership of the North-Eastern Railway, where he had established such an excellent record. Sir George will also be deputy-chairman of the Underground Co. and chairman of the Metropolitan and District. Mr. Speyer will be chairman of the Underground, and Mr. R. W. Perks, M.P., will continue as deputy-chairman of the District. At the last meeting of the Underground Co., held at Hamilton House on October 24th, Mr. Yerkes presided, and the effects of his previous illness were very plainly seen. He remained seated during his remarks to the shareholders, and said very little beyond a few characteristically terse sentences in reply to

shareholders' questions. He was then, as always, optimistic, and had no doubt that everything would be all right on the Underground lines in a very short time.

NEW COMPANIES REGISTERED.

Rangoon Electric Tramway and Supply Co., Ltd. (86,932).—This company was registered on December 20th, with a capital of £500,000 in 50,000 6 per cent. cumulative preference shares of £5 (75 rupees) each, and 250 ordinary shares of £1 (15 rupees) each, to acquire from J. W. Darwood & Co., of Rangoon, the existing Rangoon tramways (now worked by steam power), the Rangoon Tramways Order, 1905, the Rangoon Municipal Electric and Electric Traction Licences, and the Rangoon Cantonment Electric Traction Licence, granted in 1905 by the Governments of India and Burma, to supply electricity for all purposes, to electrically work the said tramways within the Municipality and Cantonment of Rangoon, and to act as electricians and tramway and railway proprietors generally. The first subscribers (each with one share) are:—J. W. W. Danson, Gresford Lodge, Gresford, merchant; J. W. Darwood, Lower Kemendine Road, Rangoon, merchant; F. Tobin, Queen Insurance Buildings, Dale Street, Liverpool, stockbroker; J. Taylor, Helsby, Warrington, manufacturer; S. Balthazar, 66, Merchants' Street, Rangoon, merchant; J. Halliday, 57½, Old Broad Street, E.C., merchant; and A. N. Hill, 10, Water Street, Liverpool, solicitor. Minimum cash subscription, 10 per cent. of the shares offered to the public. 30,000 6 per cent. preference shares of £5 (75 rupees) each and £150,000 (2,250,000 rupees) 4½ first mortgage debenture stock are being offered. The vendors are to receive £65,000 ordinary shares as purchase consideration, and they have undertaken to subscribe for at par and pay for in cash £85,000 ordinary shares. The number of directors is not to be less than three nor more than seven; the first are F. Tobin, S. Balthazar, J. Halliday, J. Taylor, J. W. W. Danson, and J. W. Darwood; qualification, £1,000; remuneration (except managing director), £1,100 divisible. Trustees for debenture stock holders: Sir John G. Hill (Hill, Dickinson & Co.), 10, Water Street, Liverpool, and R. Henderson (chairman of Anchor Line, Henderson Bros., Ltd.), Liverpool and Glasgow. The company will keep at a transfer office in Rangoon a register of members resident in Burma. Secretary (*pro tem*) and registered office, A. Goodlet, 16-18, Dale Street, Liverpool; Rangoon office, Messrs. J. W. Darwood & Co., Lower Kemendine Road, Rangoon.

Birmingham Sherardising Co., Ltd. (86,921).—This company was registered on December 20th, with a capital of £20,000 in £1 shares, to acquire the sole and exclusive licence under certain patents to use and exercise processes for depositing metals on metals, known as the "Sherardising and analogous processes," to adopt agreements (1) with P. Dawson and (2) with the "Sherardising Syndicate, Ltd.," and to carry on the business of galvanisers, zinc workers, steel and ironmasters, founders, tin-plate workers, engineers, &c. The first subscribers (each with one share) are:—J. H. Burn-Murdoch, 61, Nightingale Road, Harlesden, N.W., engineer; M. J. McTaggart, 127, Piccadilly, W., gentleman; P. Garratt, A.S.A.A., 60, Chancery Lane, W.C.; W. H. Salmon, 6, Great Winchester Street, E.C., secretary; P. Dawson, 6, Great Winchester Street, E.C., secretary; W. S. W. Bird, 70, Bishopsgate Street Within, E.C., secretary; and D. R. Crane, 42, Brownswood Road, Green Lanes, N., gentleman. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first, subject to the second agreement; qualification (except first directors), £100; remuneration, £50 each per annum and 10 per cent. of the profits remaining after 10 per cent. dividend has been paid, divisible.

G. and A. J. Cross, Ltd. (86,950).—This company was registered on December 21st, with a capital of £1,000 in £1 shares, to acquire the business carried on at 14, High Street, Tunbridge Wells, as "G. and A. J. Cross," and to carry on the business of electricians, electrical, motor, cycle and mechanical engineers, suppliers of electricity for light, heat, motive power or otherwise, &c. The first subscribers (each with one share) are:—G. Cross, 14, High Street, Tunbridge Wells, electrical and motor engineer; A. J. Cross, 14, High Street, Tunbridge Wells, electrical and motor engineer; A. Cross, 59, London Fields, Hackney, N.E., engineer; F. Cross, 1, Gibson Square, Islington, N., silversmith; Mrs. A. A. Cross, 14, High Street, Tunbridge Wells; Alice Cross, 59, Broadway, Hackney, N.E., dressmaker; and E. Cross, 59, Broadway, Hackney, N.E., silversmith. No initial public issue. Registered without articles of association.

Lancashire United Tramways, Ltd. (87,044).—This company was registered on December 29th, with a capital of £200,000 in £1 shares, to adopt an agreement with the Hon. Arthur Stanley (vendor on behalf of himself and other assenting stockholders of the undermentioned company), A. Adam, J. Beecham and R. Watson, to take over all or part of the assets of the Lancashire Electric Traction and Power Co., Ltd., to acquire, lease or construct and own any tramways and railways, to equip, maintain and work the same by electricity, steam, horse or other power, to own and turn to account omnibuses, vans and other vehicles, to act as carriers of passengers and goods, to construct, fix and maintain cables, wires, lines, accumulators, lamps and appliances, to generate, accumulate, distribute and supply electricity for light, heat, motive power and other purposes, to contract with other producers of electricity for the supply of electrical energy to be used for the purposes of this company, &c. The first subscribers (each with one share) are:—R. Watson, Linwood, near Paisley, paper maker; A. Adam, 6, York Place, Edinburgh, barrister; E. Adam, 11, Hillside Crescent, Edinburgh, advocate; J. Beecham, St. Helens, merchant; The Hon. Arthur Stanley, M.P., Knowsley, Prescot; J. M. Henderson, 2, Moorgate Steet Buildings, E.C., chartered accountant; and W. A. Bright, 15, George Street, Mansion House, E.C., solicitor. No initial public issue. The number of directors is not to be less than 5 nor more than 12; the subscribers are to appoint the first; qualification, £250; remuneration (except managing directors) not less than £250 each per annum, with £150 extra for the chairman. The assets to be acquired include leasehold land at Atherton, freehold land at Hindley, the entire issued share capitals of the South Lancashire Tramways Co., and the Lancashire Light Railways Co., Ltd., and the interest of the South Lancashire Electric Traction Co., Ltd., in about £17,000 Consols and cash, being Parliamentary deposits.

Britannia Electric Lamp Works (1905), Ltd. (86,967).—This company was registered on December 22nd, with a capital of £25,000 in £1 shares (10,000 6 per cent. cumulative preference), to adopt an agreement with the Britannia Electric Lamp Works, Ltd., and to carry on the business of lamp manufacturers, &c. The first subscribers (each with one preference share) are:—S. Horvath, Bruce Grove, Tottenham, N., electrical engineer; C. N. Radcliffe, 29, Fairfax Road, Bedford Park, W.; R. H. Molesworth, Brackenston, Pembury, Kent, electrical engineer; J. J. B. Cross, 100, Northview Road, Hornsey, N., gentleman; W. T. Smythe, Fairview, Maidstone, gentleman; A. Goddard, 46-7, London Wall, E.C., chartered accountant; and R. G. Mason, Earl's Fee Hall, Bower's Gifford, Essex, gentleman. Minimum cash subscription £2,500. The first directors are C. N. Radcliffe, R. N. Molesworth, W. T. Smythe and S. Horvath (all permanent; special qualification, 1,250 shares); qualification of ordinary directors, £10 shares or stock; remuneration of permanent directors, £208 each per annum; of others, 1 guinea each per meeting attended.

Rand Electric Syndicate, Ltd. (87,046).—This company was registered on December 29th, with a capital of £5,000 in £1 shares, to carry on in the Rand and elsewhere in South Africa the business of suppliers of electricity for light, power, heat, or other purposes. The first subscribers (each with one share) are:—W. May, 18, Austin Friars, E.C., solicitor; W. A. Pittman, Lyncote, Red Down Road, Coulsdon, Surrey, gentleman; F. C. Perrin, 23, Rylett Crescent, Ravenscourt Park, W., secretary; A. N. Smith, Merlyn, Lovelace Gardens, Southend, gentleman; G. Bostock, 21, Ironmonger Lane, E.C., chartered accountant; O. M. Brown, 21, Ironmonger Lane, E.C., articled clerk; and R. McNair, 21, Ironmonger Lane, E.C., clerk. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first.

Anglo-Japanese and Oriental Corporation, Ltd. (86,966).—This company was registered on December 22nd, with a capital of £100,000 in £1 shares, to adopt an agreement with Guaranteed Investments, Ltd., and to carry on in the United Kingdom, Japan, Korea, Manchuria, Formosa, the Far East and elsewhere the business of financiers, shipowners, concessionaires, merchants, bankers, owners of mining, planting, electrical, railway, gas, timber and trading rights and properties, builders, contractors, underwriters, stock and share dealers, &c. The subscribers (with one share each) are:—E. G. Harding, Oundle Hall, Bushey Heath, gentleman; R. T. D. Robertson, 25, Beauclere Road, W., secretary; J. W. Strange, 12, Grove Terrace, Squire's Lane, Finchley, N., merchant; C. S. Clarke, 85, St. George's Road, S.W., manager; W. H. Stapleton, 17, Navarino Mansions, Dalston, N.E., clerk; J. T. Noble, 9, St. George's Mansions, S.W., accountant; H. P. Sillitoe, 44, Barnet Grove, Hackney Road, N.E., clerk. No initial public issue. The number of directors is not to be less than two nor more than eleven; the first are Sir Wm. F. Haynes Smith, K.C.M.G., Sir Ralph D. R. Moor, K.C.M.G., Shizuo Kondo and Commander Tatzuzo Kosugi; qualification, £250 shares, debentures, or other securities; remuneration, £700 per annum for the chairman, £500 for the vice-chairman, and £300 each for the others. Voting powers: One vote for every ten shares. The directors may borrow up to an amount exceeding the nominal capital by £2,000,000 without the sanction of a general meeting. A copy of an agreement between Shizuo Kondo and Commander Tutsuzo Kosugi, of the one part, and Guaranteed Investments, Ltd., of the other part, has been filed. The agreement provides for the purchase by the last-named company from the parties first-mentioned of the benefit of certain negotiations for the acquisition of options, and also secures the services of the said vendors in carrying on such negotiations. The purchase consideration is £25,000, the purchasing company undertaking to register this company, to which the rights acquired are to be sold at a profit. The purchasing company also undertakes to procure the appointment by this company of Viscount Yenomoto, Baron Okauchi, and the Hon. Inouye as an advisory committee in Japan, with a salary of £300 per annum each. The options being negotiated for include (1) an option to purchase the steel and armour plate works and freehold site thereof known as the Kobe Steel Works; (2) an option to procure additional working capital required at the Dairi Sugar Refining Works; (3) options to extend an electric tramway system and an electric power, traction and light system in Japan; (4) an option to acquire a water-power concession (over 8,000 H.P.) in Japan; (5) an option to acquire a certain property in a coalfield in Northern Japan; (6) an option to acquire an extensive timber concession in Formosa; (7) an option to establish a gas light system in the Far East; (8) an option to erect electric power, traction and lighting plants in a large city in Southern Manchuria; (9) options to issue first debentures for a railway company and a steamship company in Japan; and (10) an option to issue first debentures for a dockyard in the Far East. The total price of this company for the purchase of the benefit of the above-mentioned agreement is not stated, but 99,993 shares are to be issued by this company to Guaranteed Investments, Ltd. Registered office, 53, Billiter Buildings, 22, Billiter Street, E.C.

Topham, Jones & Railton, Ltd. (87,032).—This company was registered on December 28th, with a capital of £500,000 in £10 shares (40,000 6 per cent. cumulative preference), to acquire the business carried on at 2, Great George Street, Westminster, as "Topham, Jones & Railton," to adopt an agreement with W. H. Topham, E. D. Jones and J. Railton, and to carry on the business of constructors, equippers, owners and workers of railways, tramways, roads, tunnels, harbours, docks, pontoons, slipways, piers, jetties, wharves, quays, canals, reservoirs, embankments, bridges, sewage, drainage, sanitary, water, gas and electric or other lighting works, telephones, telegraphs, submarine, cables, hydraulic, electric and other power supply works, stations, offices, hotels, warehouses, buildings and other public or private works and conveniences, mechanical engineers, ironmasters, colliery, mine and quarry owners, metal founders, manufacturers of iron, steel and wire, manufacturers of cables for telephonic, telegraphic, electric lighting and other purposes, builders of engines, wagons and rolling stock, producers and suppliers of gas, electric and other light, and electric, hydraulic or other power, &c. The first subscribers (each with one preference share) are:—W. H. Topham, 2, Gt. George Street, Westminster, public works contractor; E. D. Jones, 2, Gt. George Street, Westminster, public works contractor; J. Railton, 2, Gt. George Street, Westminster, public works contractor; R. H. Taylor, 2, Gt. George Street, Westminster, public works contractors' agent; J. Bushell, 2, Gt. George Street, Westminster, clerk; C. A. Witney, 2, Gt. George Street, Westminster, clerk; and J. Ashmore, 2, Gt. George Street, Westminster, clerk. No initial public issue. The preference shares do not rank in priority to the ordinary as regards capital, and they do not confer the right to attend and vote at meetings except those convened for reducing capital, winding up or sanctioning the sale of the undertaking, or at which resolutions are to be submitted relating to alteration of memorandum and articles, issue of debenture or debenture stock and other matter directly affecting the interests of the preference shareholders, unless a full year's preference dividend is more than three months in arrears. Notwithstanding the right accorded to preference shareholders to vote at meetings at which resolutions relating to issue of debentures are to be submitted, the directors are given full discretionary powers to borrow. The first directors are W. H. Topham, E. D. Jones and J. Railton, each of which may retain office while holding one-sixth of the issued shares. Ordinary qualification, 100 ordinary shares; remuneration as fixed by the company. Registered office, 2, Gt. George Street, Westminster.

Bridlington Electrical Engineering Co., Ltd. (86,995).—This company was registered on December 23rd, with a capital of £500 in £1 shares, to carry on the business of electricians, electrical engineers, &c., to take over the undertaking of a company of the same name, now carrying on business at Princess House, Bridlington, and to adopt an agreement between G. F. Cook, of the one part, and Mary L. Cook and Mary J. Sewell, of the other part. The first subscribers (each with one share) are:—W. Wakelen, Cardigan Road, Bridlington, broker; Mrs. M. L. Cook, Princess Street, Bridlington; E. Garland, Promenade, Bridlington, newsagent; E. T. Chittenden, Wellington Road, Bridlington, clothier; G. F. Cook, Chapel Street, Bridlington, electrical engineer; Mrs. M. J. Sewell, Princess Street, Bridlington; and J. E. Garland, Vernon Road, Bridlington, decorator. No initial public issue. Registered without articles of association. Registered office, Princess House, Princess Street, Bridlington, Yorks.

Chichester Electric Light and Power Co., Ltd. (86,998).—This company was registered on December 23rd, with a capital of £20,000 in £1 shares, to carry on at Chichester, Sussex, and elsewhere the business of electrical engineers, electricians, practical engineers and contractors, manufacturers of and dealers in electrical apparatus, mechanical and chemical engineers, producers and suppliers of light, heat, sound and power by electricity, galvanism, magnetism, gas or oil, &c. The first subscribers (each with one share) are:—J. D. H. Cuthbert, 11, Grand Parade, Finsbury Park, N., accountant; B. Thomas, 11, Corporation Road, Woodside, Surrey, clerk; A. H. Malet, 29, London Road, Forest Hill, S.E., gentleman; P. A. Allen, 26, Finchley Road, Westcliffe-on-Sea, secretary; H. Newson, 66, Avondale Road, Croydon, manager; J. Mann, 10, Huntley Road, South Norwood, clerk; and T. Bird, 3, Heathfield, Wandsworth Common, S.W., clerk. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first.

Tasker's Engineering Co., Ltd. (87,052).—This company was registered on December 29th, with a capital of £25,000 in £1 shares, to acquire the business of a manufacturing, mechanical, electric and general engineer, engineers' factor, rubber merchant, spiral blade and stone-cutting tool manufacturer, &c., carried on by J. H. R. Tasker at 59 and 61, Blonk Street, and at Portmahon Works, Watery Lane, Sheffield, as "Tasker's Engineering Co." The first subscribers (each with one share) are:—J. H. R. Tasker, Baslow, manufacturer; J. Snow, Dronfield, engineer; P. H. Pilling, Steade Road, Sheffield, secretary: J. H. Tasker, Baslow, engineer; T. E. Shuttleworth, 5, Park Avenue, Sheffield, chartertered accountant; C. Barker, 7, St. James' Row, Sheffield, solicitor; and T. G. Shuttleworth, 13, Montgomery Road, Sheffield, chartered accountant. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. H. R. Tasker, J. Snow, and P. H. Pilling. The said J. H. R. Tasker is permanent, subject to holding quarter of the issued share capital, and has power to appoint other directors; qualification of ordinary directors, £500; remuneration as fixed by the company.

ELECTRICITY SUPPLY ACCOUNTS.

South Shields Municipal E.L. Supply.

The ninth yearly return of this Tyneside undertaking shows a steady improvement in output and costs. The department at present gives a single-phase alternating supply, and evidently suffers from the lack of a motor load, for which the local conditions would appear to offer facilities. It is, however, anticipated that a traction supply will be given in the near future to the local tramways and thus materially improve the working conditions. Public lighting by electricity is being gradually extended, and an improved price has been obtained for it. The charges were—private lighting, 7d. and 2d. maximum demand system, and 5d. to 3d. per unit on a sliding scale; power, 2d. per unit; public arcs, £22 10s.; and incandescents, £2 6s. (2 16-c.p.) per annum. The chief engineer is Mr. J. H. Cawthra.

General Statement.

For year ending March 31st	1905.	1904.
Total capital expended	£151,838	£149,356
Number of units sold—		
Private lighting	879,227	848,109
Public lighting	506,166	451,180
Total number of units sold	1,385,393	1,299,289
Equivalent No. of 8-c.p. lamps connected	59,209	53,837
Number of public lamps	91 arc. 462 inc.	88 arc. 432 inc.
Maximum load in kw.	953	909
Revenue account—		
Gross revenue	£18,132	£17,165
„ expenditure	£6,936	£6,601
„ profit	£11,196	£10,564
Average price obtained per unit—		
Private lighting	3·8d.	3·8d.
Public lighting	1·6d.	1·3d.

Revenue Account for Year ending March, 1905.

Gross revenue	£18,132 =	3·15d. per unit.
Works and distribution costs (including public lighting)	£4,278 =	·74d. „
Total working costs	£6,936 =	1·19d. „

Profit Statement, 1905.

Interest on loans, &c.	£4,899
Sinking fund charges	4,231
Sundry	78
Balance on year's working	1,988
Gross profit	£11,196

Salford Municipal Electricity Supply.

Time was when one glanced with a certain amount of foreboding at the Salford returns; the last few years, however, have produced a welcome change, the result of a combination of circumstances, probably well known to the reader. At the present time the Salford undertaking ranks as one of the most efficiently worked in the kingdom, with the low figure of ·67d. per unit working costs for the last working year.

The conditions which led up to this satisfactory result were a heavy tramway load and a rapidly growing output for motive power, which exceeds that for lighting at the present time, and which together resulted in a 28·5 per cent. load factor.

The total cost of production, including financial charges, amounted to 1·54d. per unit, made up as follows:—

Coal, ·19d.; oil, &c., ·03d.; wages, ·12d.; repairs, &c., ·15d.; rents, &c., ·06d.; management, ·12d. (or total working costs, ·67d.), and interest and sinking fund, ·87d.

All the above items show a reduction compared with the previous year, except that for management, which includes the cost of the Prestwich Electric Lighting Prov. Order. The motors on hire by the department reached a total of 1,367 h.p. out of the 2,817 h.p. connected.

The result of the year's working was a gross profit of £40,696, being a slight reduction on that of the previous year, when the charges for energy were on a higher scale.

The net profit of £7,514 was allocated as to £3,000 to depreciation, &c., and £4,514 in relief of the rates.

The progress made by the department is a matter for congratulation to the chief engineer, Mr. C. D. Taite, with whom we cordially agree in regard to the inadequate scale of depreciation payments.

The prices charged were:—Private lighting, 3½d. per unit, or 1s. per 8-c.p. lamp per quarter and 1½d. per unit; power 2d. to 1d., and traction 1½d. per unit.

General Statement.

For year ending March 31st	1905.	1904.
Total capital expended	£542,653	£530,447
Number of units sold—		
Private lighting	1,409,523	1,140,244
„ power	1,411,551	911,236
Public lighting	184,196	179,082
Traction	5,997,040	5,251,055
Total number of units sold	9,002,310	7,481,617
Equivalent No. of 8-c.p. lamps connected	125,694	109,582
h.p. of motors connected	2,817	2,002
Number of public lamps	116 A	108 A
Maximum load in kw.	3,600	3,200
Revenue account—		
Gross revenue	£66,006	£66,813
„ expenditure	£25,310	£23,952
„ profit	£40,696	£42,861
Average inclusive price obtained per unit—		
Private supply	2·17d.	2·56d.
Public lighting	1·28d.	1·22d.
Traction	1·50d.	1·95d.

Revenue Account for Year ending March, 1905.

Gross revenue	£66,006 =	1·76d. per unit.
Total working costs	£25,310 =	·67d. „

Profit Statement, 1905.

Interest on loans	£16,455
Sinking fund	16,727
Balance on year's working	7,514
Gross profit	£40,696

CITY NOTES.

Manx Electric Railway Co.

A meeting of the shareholders of this company was held on Wednesday at the offices, 78, Cornhill, Mr. A. G. Boscawen, M.P., in the chair.

In proposing the adoption of the report, the Chairman said it was a matter of satisfaction to the board that they were able to present a better report than that which they issued last year. The receipts were up £1,820, having amounted to £32,638 as compared with £30,818 last year. On the other hand, there was a decrease in the expenditure of £1,931, the amounts being £15,348, as against £17,279. That showed a ratio of working expenses to receipts of 47 per cent., as against 56 per cent. last year. While, however they had those increased net earnings, it must be mentioned that owing to additional capital expenditure, debenture interest this year would absorb £91 more, and the preference interest would amount to £750 additional. The improvement in the receipts was due to the fact that they had experienced a better season in the Island. They were a pleasure line, and they depended very largely upon two most uncertain elements—one was the weather, and the other was the prosperity of the people of Lancashire and Yorkshire. If they got a fine August the receipts were sure to be "up," and if they got it wet they were sure to be "down." If the latter part of last August had been as fine as the first part, their receipts would have been considerably larger than they were. Lancashire had been going through a period of acute depression which had affected the company very much last year. The depression was mending, and if they could count upon a continuance of that improvement and got good weather next August there was every prospect that they would do much better in the coming year. The expenditure showed a decrease all round. The mileage this year was 398,692 miles, as against 437,622—a decrease of 38,930, which he thought was very satisfactory in face of an increased earning of £1,830. The passenger receipts per car-mile on the Douglas and Ramsey section were 18·85d. this year, as against 16·78d.—in other words, they had earned about 2d. per passenger more per car-mile. The result was very similar on the Snaefell line, where the passenger receipts had amounted to 43·73d. per car-mile, as against 41·27d. The total expenditure per car-mile had been reduced from 9·5d. to 9·2d. The only unfortunate thing that had occurred during the year was the accident which they had last September at Snaefell which resulted in injuries to a certain number of persons and to damage to rolling stock. The board had very carefully considered the cause of that accident, and had come to the conclusion that every possible precaution was taken on the occasion that they and the staff thought necessary. However, they had since issued fresh regulations for the working of the line and taken certain steps in regard to altering the brake powers, which would render anything of the kind absolutely impossible in the future. Although they were insured against accidents up to a certain point, he was afraid that point would be somewhat exceeded in this case. As yet, however, it was impossible to say exactly how much the accident would cost them, and that was why they had carried forward such a large sum as £2,204, which, he hoped, would prove a great deal more than sufficient. The had made certain proposals to the Douglas Corporation for the electrification of the horse tramway on the front, which, if successfully carried through, would, he believed, benefit the company.

Mr. Ernest Schenk seconded the motion, and the report was adopted.

Edmundson's Electricity Corporation.—The directors have declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the half-year ended September 30th, 1905.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
†Aberdeen	Dec. 23	1,236	+ 53	30	42,409	— 1,186	..	..
†Ayr	,, 23	187	+ 10	31	10,335	— 121	8	..
Bath	,, 27	1,574	+ 281	52	35,631	+ 2,645	13	..
Birkenhead	,, 31	2,054	— 37	39	40,785	— 646	13·5	..
Blackburn	,, 27	1,943	+ 157	39½	38,841	+ 1,692	13·75	..
Blackpool Corp.	,, 28	696	+ 83	39	45,356	+ 1,890	11·87	..
,, —Fleetw'd	,, 30	420	+ 14	26	20,230	— 1,092	..	..
,, —Lytham	,, 28	338	+ 80	8	1,252	+ 143	7½	..
Bolton	,, 31	3,745	+ 306	40	76,764	+ 3,351	26	+ 1
Bournemouth	,, 27	3,028	+1,110	38½	55,568	+11,974	17·4	+ 7½
Bradford	,, 30	8,760	+1,059	39	172,601	— 4,036	53	..
Brighton	,, 31	1,782	+ 26	40	40,767	..	9·5	..
Bristol	,, 29	10,581	+ 41	..	..	..	28·5	..
Brit. Elec. Trac. Co.								
Airdrie	Dec. 22	428	+ 67	51	10,544	+ 297	8·5	..
Barnsley	,, 22	308	+ 10	,,	8,182	— 318	3	..
Barrow	,, 22	414	+ 38	,,	12,178	+ 2,270	5·37	..
‡Birmingham (City)	,, 22	10,645	— 387	,,	273,143	— 191	14·5	..
Birmingham (Mid.)	,, 22	2,799	— 394	,,	79,858	— 721	12·25	..
Devonport	,, 22	844	— 104	,,	23,258	— 3,483	8·85	..
Dudley—Sto'rb'ge	,, 22	1,550	+ 141	,,	45,328	+ 1,725	21·25	..
Gateshead	,, 22	1,895	+ 139	,,	47,131	+ 1,162	11·25	..
Gravesend, N'fleet	,, 22	402	+ 49	,,	11,634	— 837	6·5	..
Gr'n'k, Pt. Glsgw	,, 22	1,230	+ 270	,,	32,780	+ 3,757	7·25	..
Hartlepool	,, 22	494	+ 19	,,	13,553	— 1,164	6·72	..
Kidderminster	,, 22	184	— 11	,,	6,078	— 345	4·5	..
Leamington	,, 22	260	+ 98	23	4,149	+ 1,513	..	..
Merthyr	,, 22	348	+ 3	51	9,601	— 513	2·9	..
‡Metropolitan	,, 22	5,314	+1,724	,,	135,698	+56,827	..	..
Middleton	,, 22	564	+ 93	,,	17,088	+ 857	8·5	..
Oldham — Ashton	,, 22	1,063	+ 165	,,	28,428	+ 943	9·13	..
Peterborough	,, 22	198	— 9	,,	6,767	— 687	5·31	..
Potteries	,, 22	3,592	+ 301	,,	87,688	+ 1,326	29	..
Rothesay	,, 22	78	+ 19	,,	9,619	+ 2,707	2·75	..
Sheerness	,, 20	95	— 20	,,	3,484	+ 251	2·5	..
Southport	,, 22	435	+ 9	,,	15,595	— 534	8·17	..
South Staffs.	,, 22	1,580	+ 335	,,	37,976	+ 2,174	13·87	..
Swansea	,, 22	1,491	+ 582	,,	36,913	+ 9,748	5·5	..
Taunton	,, 22	83	+ 1	,,	2,142	— 225	1·5	..
Tynemouth	,, 22	345	+ 7	,,	12,904	— 1,583	3·75	..
Weston-s-Mare	,, 20	52	+ 2	,,	6,829	+ 597	3	..
Wolverhampton D.	,, 22	772	+ 107	,,	20,181	+ 490	14·75	..
‡Worcester	,, 22	479	— 29	,,	15,207	+ 346	5·75	..
Wrexham	,, 22	187	+ 7	,,	5,112	— 352	4	..
Yorks. Wool. Dist.	,, 22	1,601	+ 653	,,	34,428	+ 5,177	17	..
Burnley	Dec. 30	2,335	+ 264	..	..	..	7·5	..
Burton-on-Trent	,, 31	596	— 10	39	12,275	..	8·5	..
Bury	,, 24	1,526	..	38	28,504	..	10·5	..
†Cardiff	,, 16	1,803	— 78	37	76,534	— 32	15·8	..
Carlisle	,, 30	363	+ 5	52	9,463	— 662	..	..
†Chatham and Dist.	,, 21	603	+ 107	51	33,196	+ 3,619	9·3	+ 8
†Colchester	,, 20	141	— 27	21	4,029	— 1,321	7	..
Cork	,, 28	955	+ 5	52	24,269	+ 646	9·89	..
Coventry	,, 14	815	+ 8	50	23,960	+ 642	9·89	..
†Darlington	,, 23	208	+ 23	38	7,832	..	4·87	..
Darwen	,, 29	506	+ 32	39	9,550	+ 500	4·36	..
Dover	,, 30	408	+ 2	39	9,007	— 41	4·75	+ 1½
Dublin	,, 29	10,249	+ 358	..	131,583	+ 101	48·5	+ 1·5
Dundee	,, 27	1,949	+ 279	32	29,700	+ 2,021	12·5	..
East Ham	,, 30	1,742	+ 499	39	32,546	+ 4,156	8	+ 2
Glasgow	,, 30	31,507	+3,331	30	468,968	+28,271	76	+ 3·5
Gloucester	,, 27	521	+ 21	40	11,640	..	9	..
†Halifax	,, 20	1,372	+ 222	38	60,617	+ 4,031	37	+ 2·5
†Huddersfield	,, 30	1,309	+ 58	39	53,576	+ 2,590	28	..
Hull	,, 30	4,782	+ 187	39	87,363	+ 1,048	13	..
Ilford	,, 30	914	+ 139	39	18,685	+ 634	..	..
Ilkeston	,, 27	233	+ 26	39	4,664	— 750	3·5	..
Ipswich	,, 30	774	— 13	39	17,183	— 1,872	10·5	..
Isle of Thanet	,, 30	537	— 37	52	31,618	— 3,282	..	..
Kirkcaldy	,, 27	409	+ 15	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 28	1,653	+ 473	52	39,263	+ 5,521	12·5	+ 3·9
Leeds	,, 23	11,842	+1,146	38	231,043	+ 6,632	89·5	+ 8
Leicester	,, 30	4,529	+ 564	52	107,829	+30,727	..	..
†Liverpool	,, 16	10,237	+ 116	50	527,277	+10,662	104	+ 1
L.C.C.	,, 16	26,638	+2,253	37	549,836	+74,507	51	+ 4½
Lowestoft	,, 31	307	..	13	1,959	— 26	3·5	..
Manchester	,, 30	25,872	+2,897	39	595,578	+24,536	..	..
†Newcastle	,, 23	4,067	+ 330	38	145,327	+ 3,699	..	..
†Newport	,, 30	651	+ 32	13	7,111	+ 492	14·5	+ 1·5
†Oldham	,, 24	1,666	+ 408	39	64,121	+16,080	23·75	+ 1·6
Plymouth	.. ..	..	..	..	..	..	..	..
Pontypridd	,, 30	355	..	39	6,372	..	3·5	..
Portsmouth	,, 30	3,006	+ 12	39	78,660	+ 1,223	14·5	..
Preston	,, 27	1,364	..	..	..	..	..	..
†Reading	,, 7	556	+ 14	36	23,006	— 484	..	..
Rochdale	,, 30	1,665	+ 896	39	30,620	+21,173	21·3	+ 5·8
Salford	,, 25	8,468	+ 941	39	166,940	+ 9,754	..	..
†Scarborough	Nov. 25	49	..	46	7,735	..	4·5	..
†Sheffield	Dec. 24	5,290	+ 825	39	192,624	+10,188	35·75	+ 1·5
Southampton	,, 27	1,807	+ 3	12	10,899	— 308	..	..
Southend-on-Sea	,, 27	509	+ 59	39	15,226	+ 810	6	..
Stalyb'dge, Hyde, &c.	,, 23	1,161	+ 456	38	24,579	..	21	..
†Stockport	,, 15	808	+ 410	41	28,314	+ 7,030	15·5	+ 4
†Sunderland	,, 24	1,328	+ 125	38	50,912	+ 1,905	..	..
Swindon	,, 27	388	+ 18	39	7,730	..	4·4	..
Tyneside	,, 27	754	+ 57	52	21,198	+ 1,182	8·87	..
Warrington	,, 21	665	+ 55	38	12,963	+ 731	6·37	+ ·25
West Ham	,, 28	4,382	+2,109	39	71,091	+30,359	14·7	+ 4·9
†Wolverhampton	,, 20	760	..	..	..	..	10	..
Cen. London Rly.	Dec. 30	13,179	— 860	26	165,968	— 1,436	6	..
City & S. Lon. Rly.	,, 31	5,983	—1,005	26	69,363	— 412	6·25	..
Dublin-Lucan Rly.	,, 31	285	+ 19	26	3,268	— 15	7	..
G. N. and City Rly.	,, 30	3,658	+ 76	26	41,450	+ 8,162	3·5	..
L'pool Overh'd Rly.	,, 31	2,727	— 201	26	38,959	— 1,964	6·57	..
Mersey Railway	,, 30	3,721	— 167	26	41,795	+ 2,114	4·5	..
‡Metropolitan Rly.	,, 31	36,629	+ 782	26	450,109	+ 3,425	70·5	
Met. District Rly.	,, 31	15,994	+1,263	26	186,643	+ 5,090	24	

* Compared with the corresponding period of 1904. † One week only.

‡ Includes horse, steam and other receipts.

STOCKS AND SHARES.

Wednesday evening.

New Year markets opened 1906 in good style. The Stock Exchange was busy in nearly all its departments, and the voice of the buyer largely predominated. Release of dividend money and an easier tendency in Lombard Street gave additional impulse to the more cheery tone generated by the sentimental optimism of another year's commencement. It goes without saying, we suppose, that the best prices were not maintained, but sufficient strength remains to encourage the belief that public confidence is less affected now by the Russian terrors, the General Election, or other influences extraneous to the intrinsic value of securities.

Electrical lists are noted for the number of stocks and shares quoted *ex* dividend. There are some dozens of them in the succeeding pages, and the patient examiner who has tested each one can assure his readers that in no case is there a significant change produced in the price. Some few examples have recovered the amount deducted, but in the great majority of instances the deduction is faithfully reflected in the sum by which the price has been lowered.

By the death of Mr. Charles T. Yerkes, the electric traction world loses a figure of remarkable interest and strength. It was not always possible to see eye to eye with this commanding personality, and Mr. Yerkes did not convince everybody when he replied to certain of our criticisms at the last meeting of the London United Tramways Co., at which he occupied the chair. Some of his exploits in Chicago were better left unsung, but no one could refuse admiration to the strenuous energy and the determination with which Mr. Yerkes applied himself to traffic problems of every kind—financial, technical, Parliamentary and so forth. District stock rose to 36½ upon the announcement that Sir George Gibb, the famous manager of the North-Eastern Railway, has resigned his position to take up the Chairmanship of the District Railway. He also becomes managing director of this and of the Underground Electric Railways of London, Mr. Edgar Speyer succeeding Mr. Yerkes as Chairman of the latter.

Metropolitan Consolidated is dull at 86½, but except for this the electric railway section is unaltered.

In the Traction market, the payment of the dividend on London United Tramways Preference allayed a few apprehensions, and the price of the shares is 9¾ *ex* the 5s. dividend. British Electric Tractions are better in tone, and can only be picked up with difficulty at 8½. It is observable that Metropolitan Electric Tramways 4½ per cent. Debenture stock fell 4 points to 103, although the interest deduction was only 2¼. To-day, Wednesday, the price was put up to 105; somebody evidently blundered. Calcutta Trams new shares at 8¾ are *ex* 2s. 6d. dividend, but have not altered in price. Yorkshire (West Riding) Electric Tramway Debenture was done on Tuesday at 95¼.

Supply shares are at last quieting down, and one or or two rises have actually occurred. The shares favoured were Metropolitan Ordinary and London Electric Supply Preference, both of which rose 5s. Brompton and Kensington lost a similar fraction, and so did St. James' and Pall Mall Preference. Other alterations were the result of dividend distributions; but, after the long spell of weakness experienced by the Electric Supply market, there is pleasure in being able to speak of a better tone amongst prices.

Manufacturing issues are also inclined to advance here and there. Willans & Robinson Preference have been wanted at 3½ without finding sellers, and the price accordingly hardened to 3¾. India-Rubber shares are really 5s. better, while showing a 10s. loss, for the deducted dividend was 15s. General Electric Preference are 9¼, *ex* 5s. We have not heard of buyers yet for the Ordinary shares. A rise of 5s. makes British Aluminium 6 per cent. Preference 5¼, and Castner-Kellner at 1½, are $\frac{1}{16}$ better.

Amongst Telegraphs, Eastern Ordinary stock rose a point to 146½, and Eastern Extension shares fell ¼ to 14½, the movements bringing the two descriptions almost together again. The Anglo-American Telegraph group hardened upon dividend prospects, and the heavy business being done in the American Railroad market. Anglo "A," however, fell off to 17. Great Northerns are again somewhat lower, after making allowance for the coupon, and Western Telegraphs lost the ¼ that they gained last week. Globe Telegraph and Trust, of both kinds, are better, upon the general hardness in this market, and Telegraph Constructions have firmed up to 33½, which is a 10s. rise.

No alteration has taken place in National or other telephone issues, beyond that caused by a few *ex* interest and dividend markings.

City of London Electric Lighting Co.—Warrants in payment of the half-year's interest to December 31st, 1905, on the £400,000 5 per cent. first and £300,000 4½ per cent. second debenture stocks, have been duly posted.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905. §	Closing Quotations Dec. 27th.	Closing Quotations Jan. 3rd.	Business done week ended Jan. 3rd, 1906. Highest	Lowest.	Rise + or Fall —
17,700	African Direct Telegraph, 4 % Debs...	100	4 %	4 %	4 %	4 %	99—102	98 —101	..	..	—1
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3⅜— 4½	3⅜— 4½	..	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	85 — 90	83 — 88 xd	84	..	..
702,600	Anglo-American Telegraph	Stock	60/6	61s.	29⅜	29s. §	62 — 64	62½ — 64½	..	..	+ ½
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5⅜ %	58s. §	109 —110	109½—110½	110⅜	109½	+ ½
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	..	17⅛— 17⅜	16⅛— 17⅛	17 1/16	17 1/16	— ⅛
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	102 —104	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	7⅜— 8	7⅜— 8⅛	8	..	+ ⅛
1,932,856£	Commercial Cable Stng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	96½— 96⅞	96 — 98 xd	98⅛	98	..
16,000	Cuba Telegraph	10	6⅔ %	10 %	5 %	5 % §	8½— 9	8½— 9	8 1/16	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 % §	17 — 18	17 — 18	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 % §	3⅛— 3⅜	3⅛— 3⅜	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 % §	8½ — 9	8½ — 9	..	..	— ½
30,000	Do. do. 4½ % Debs.	50	4½ %	4½ %	4½ %	4½ % §	100 —103	98 —101 xd	..	..	..
60,710£	Direct United States Cable	20	3⅛ %	3 %	3⅛ %	3 % §	14 — 15	14 — 15	14⅛	14⅜	..
70,000	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½ %	4½ %	4½ %	4½ %	101 —103	99 —101 xd	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	5 % §	144 —147	145 —148	147½	145½	+1
2,000,000	Do. 3½ % Pref. Stock	100	3½ %	3½ %	3½ %	3½ % §	90 — 92	90 — 92	91	..	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 % §	106 —108	106 —108	106½	..	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	6 % §	14½— 15	14½— 14⅝	14⅝	14⅜	— ⅛
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 % §	106 —108	106 —108	..	..	..
300,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100½—102½	..	..	+ ⅛
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	100 —102	100½—102½	..	..	+ ⅛
180,887	Globe Telegraph and Trust	10	£3	5⅛ %	5⅜ %	5 %	10½— 10⅝	10½— 11	10 5/8	10 1/8	+ ⅛
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14¼— 14⅜	14⅛— 14½	14 1/16	14 1/8	+ ⅛
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½ %	15 %	24 %	..	36½— 38½	35 — 38	..	..	— ½
42,300	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½ %	4½ %	4½ %	4½ %	101 —103	99 —101 xd	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	5 %	57 — 59	57 — 59	57 1/16	57 1/8	..
251,127	Marconi's Wireless Telegraph	1	..	..	..	..	1⅛— 1⅜	1⅛— 1⅜	..	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅞— 1	⅞— 1	..	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅞— 1	⅞— 1	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 % §	110½—111½	110½ — 111½	111½	108½	..
1,966,667	Do. do. Def. Stock	100	4½ %	5 %	5 %	5 % §	108 — 110	108 — 110	109½	109½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 % §	13 — 15	13 — 15	14⅛	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 % §	11 — 13	11 — 13	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 % §	5⅜— 5⅝	5⅜— 5⅝	5⅜	5 1/16	..
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½ %	3½ %	3½ %	3½ %	98½—100½	98 —100 xd	99⅛	..	..
1,689,593	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	104 —106	102½—104½xd	..	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½ %	6½ %	6 %	1⅛— 1⅜	1⅛— 1⅜	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅛— 1⅜	1⅛— 1⅜	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	..	95 — 97 xd	98 —101 xd	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	97 — 99	98 —101 xd	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 % §	7⅛— 7⅜	7⅛— 7⅜	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½ %	103 —106	101 —104 xd	..	..	..
3,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	125—128	125 —128	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7⅛— 8	7⅜— 7⅝xd	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5⅛— 5⅜	5⅜— 5⅝xd	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	111 —113	109 —111	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½ %	4 %	9⅛— 10	9⅛— 10	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	1/16— 1/8	1/16— 1/8	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100⅛—102½	99 —101 xd	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	5 %	14 — 14⅛	13⅞ — 14⅛	14 3/16	14	— ⅛
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	5 %	102 —104	100 —102 xd	..	..	..
563,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103⅛—105⅛	101⅛—103⅛xd	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅛— ¼	⅛— ¼	..	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	6 %	8¼— 8½	8¼— 8½	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6¾— 7½	6¾— 7½	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	101 —104	99 —102 xd	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 260,008 to 430,007	5	..	..	8 %	6 % §	8⅜— 8⅝	8⅜— 8⅝	8 1/16	8¼	..
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½ %	5¾— 6⅛	5⅞— 6 xd	6	5⅞	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	142 —145	140 —143 xd	141½	141	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	105 —107	103 —105 xd	105	..	..
800,000	Babcock & Wilcox, 1 to 800,000	1	..	17 %	20 %	16 %‖	3⅞— 4	3⅞— 4	77/6	76/10½	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..
40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	3/6	5¼— 5⅜	5⅛— 5⅜	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	3/-	4⅜— 5¼	5 — 5½	..	..	+ ⅛
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2⅜— 3⅛	2⅜— 3⅛	..	..	..
300,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	98 —102	98 —102	..	..	..
300,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	..	119 —122	120 —123	122	..	+1
300,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	..	107 —111	107 —111	108⅛	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	106 —109	106 —109	109⅛	..	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	..	4½ %	4½ %	4½ %	103 —105%	103 —105 %	103⅜	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½ %	4½ %	4½ %	102 —105	102 —105	..	..	..
133,301	British Electric Traction	10	8 %	6 %	6 %	..	7⅛— 8⅛	8⅛— 8⅜	8 7/16	8⅛	+ ⅛
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	..	10 — 11	10⅛— 11	10 11/16	10½	+ ⅛
1,415,422£	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	117 —119	118 —120	119⅛	..	+1
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½ %	4½ %	97 — 99	98 —100	98⅜	..	+1
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 % §	6¾— 7	6¾— 7	..	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 % §	5⅞— 6⅛	5⅞— 6⅛	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½ %	4½ %	4½ %	4½ % §	103 —106	103 —106 xd	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½ %	4½ %	4½ %	98 —100	98 —100	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1⅞— 2⅛	1⅞— 2⅛	44/41½	41/10½	..
1,016,353	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	80 — 85	80 — 85	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	9/16— 11/16	9/16— 11/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	..	⅛— ¼	⅛— ¼	9/41½	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1⅛— 1⅜	1⅛— 1⅜	..	..	..
125,000£	Do. 4½ % Perp. Deb. Stock ..	Stock	4½ %	4½ %	4½ %	4½ %	96 —100	96 —100	..	..	..
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½ %	4½ %	4½ %	4½ %	84 — 86	82 — 84 xd	83	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	..	3⅜— 3⅝	3⅜— 3⅝	..	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	..	5 1/16— 5 1/8	5⅛ — 6	..	..	+ 1/16
27,500	Do. "B" do. 1 to 27,500	5	..	6 %	6 %	..	5 — 5⅛	5 — 5⅛	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	107 —109	105 —107 xd	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	100 —103 xd	104½	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	7 % §	9¼— 9⅝	9¼— 9⅝	..	..	..
32,610	Do. 105,001to 137,610	5	..	..	..	3d.	8¾— 9	8¾— 9 xd	..	..	..
350,000	Do. 4½ % 1st Deb. Stock	100	..	4½ %	4 %	4½ %	107 —109	105 —107 xd	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½ %	12½ %	10 %	11 — 12	11 — 12	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5⅞	5⅛— 5⅜xd	5⅜	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½ %	4½ %	4½ %	4½ %	109 —111	107 —109 xd	107¼	107	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 % §	⅞— 1⅛	⅞— 1⅛	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	..	1 — 1⅛	1 1/16— 1 3/16	23/8	23/16	+ 1/16
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½ %	4½ %	4½ %	97 —102	97 —102	..	..	..
1,939,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 % §	93 — 95	94 — £6	95⅛	94	+1
580,316	Do. do. 4 % Pref. Stock ..	Stock	4 %	4 %	4 %	4 % §	101 —103	101 —103	102⅜	..	..
580,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	..	85 — 88	85 — 88	..	..	..
1,480,000	City and South London Railway	Stock	3⅛ %	2⅜ %	2⅛ %	2 % §	44 — 46	44 — 46	45⅜	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	£	5 %	2½ %	2½ %	..	2 1/16— 2 1/8	2 — 2⅛	..	..	— 1/16
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	107 —109%	105 — 98% xd	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued).*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	§1905.	Closing Quotations Dec. 27th.	Closing Quotations Jan. 3rd.	Business done week ended Jan. 3rd, 1906. Highest	Lowest.	Rise + or Fall−
52,000	Dick, Kerr & Co., 1 to 52,000	£	..	..	10 %	..	8½ — 9	8½ — 9	..	..	..
61,000	Do. do. 6 % Cum. Pref., 1 to 61,000	5	..	6 %	6 %	6 %	5⅞ — 6¼	5⅞ — 6¼	..	..	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	106 —108	104 —106 xd	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½%	6 %	3 %	13½ — 14½	13½ — 14½	..	..	..
59,987	Do. 6 % Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14½ — 15½	14½ — 15½	..	..	..
63,400	Do. 4 % Debs.	100	..	4 %	4 %	4 %	99½—100½	99½—100½	..	..	..
300,000	Do. 3½ % "A" Debs.	100	..	3½%	3½%	3½%	98 — 99	98 — 99	..	..	..
300,000	Do. 3½ % "B" Deb. Stock	100	..	3½%	3½%	3½%	96 — 97	96 — 96½	..	..	— ½
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	£	Nil	Nil	2½%§	..	1⅜ — 1⅝	1⅜ — 1⅝	28/9	..	..
17,139	Do. "A" shares, 01—017,139	£	Nil	Nil	2½%§	..	2¼ — 2⅜	2¼ — 2⅜	..	..	..
344,023	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	85 — 90	86 — 88 xd	..	..	..
100,000	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	92 — 97	92 — 97	..	..	..
112,100	Electric Construction 1 to 112,100	£	6 %	4 %	Nil	..	⅜ — ⅝	⅜ — ⅝	..	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	£	7 %	7 %	7 %	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	92 — 95	92 — 95	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9¼ — 9⅞	9 — 9½ xd	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	96 —100	96 —100	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %§	5 — 5½	5 — 5½	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 11½	10½ — 11½	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —104	102 —104	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	£	20 %	15 %	15 %	10%§	12½ — 13½	12½ — 13½	12⅝	..	..
200,000	Do. do. 4½ % Pref.	£	4½%	4½%	4½%	4½%	5⅜ — 5⅝	5⅜ — 5⅝	5 1/16	5⅛	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	.. ..	.. ..	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works..	10	10 %	10 %	5 %	2½%§	18 — 19 xd	18 — 19 xd	..	..	..
800,000	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	1½%	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6½ — 6⅞	6½ — 7	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	4 %§	9 — 11	10 — 11	..	..	..
399,930	Do. do. 60,008 to 100,000 (£4 paid)	10	..	8 %	6 %	4 %§	4 — 5	4 — 5	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	9⅞ — 10½	9¼ — 10 xd	..	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	100 —103	98 — 101 xd	98¾	..	..
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	..	7/32 — 3/32	3/32 — 3/32	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1 — 1 1/16	1 — 1 1/16	..	..	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	106 —108	104—106 xd	..	..	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	5 — 5½	5 — 5½	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	..	8⅞ — 9¼	8⅝ — 9¼	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	9¼ — 10⅛	9⅜ — 10⅛	9⅜	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 — 106	..	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	10 %	32 — 34	32¼ — 34½	32¼	..	+ ½
150,000	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	102 —104	100 —102 xd	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	97 — 98 xd	96½ — 97½	..	..	— ½
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3⅜%	3 %§	94 — 97	94 — 97	..	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8⅓%	6 %§	..	..	1⅜ — 2¼	1⅜ — 2¼	2	..	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	..	..	3¼ — 3¾	3⅜ — 4	3⅜	3⅜	+ ½
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	82 — 87	82 — 87	84	83½	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 %§	5½ — 5⅝	5½ — 5⅝	..	..	..
50,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	£	8 %	10 %	10 %	9 %	8⅞ — 9⅛	8½ — 9½	9⅜	..	— ½
10,623	Do. do. 7 % Cum. Pref.	£	7 %	7 %	7 %	7 %	9 — 9½	9 — 9½	..	..	..
300,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	102 —105	102 —105	..	..	..
80,000	Charing Cross and Strand Electricity Supply	£	10 %	8 %	8 %	5 %§	5⅝ — 6⅜	5⅝ — 6⅜	6⅛	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	£	4½%	4½%	4½%	4½%	5⅛ — 5⅜	5⅛ — 5⅜	5⅛	..	..
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	£	4½%	4½%	4½%	4½%	4⅜ — 5	4⅜ — 4⅝ xd	..	..	..
40,000	Do. do. 1903	£	..	4½%	4½%	4½%	4⅜ — 5	4⅜ — 4⅝ xd	..	..	..
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —103 xd	101 —103	103	..	..
44,436	Chelsea Electricity Supply, Ord.	£	4½%	5½%	6 %	4½%§	5 — 6	5 — 6	5⅝	..	..
175,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%§	110 —112	108 —110 xd	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	5 %	11 — 12	11 — 12	11	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	13½ — 14½	13½ — 14½	..	..	..
400,000	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	124 —128	122 —126 xd	..	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	103 —105	101 —103 xd	..	..	..
40,000	County of Durham Electrical Power, Ord.	£	..	..	..	..	2 1/16 — 2 1/8	2 1/16 — 2 1/8	..	..	..
50,000	Do. do. 5 % Pref.	£	..	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	4 %§	8½ — 9¼	8¼ — 9¼	..	..	..
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	12⅜ — 12¾	12⅜ — 12¾	12 1/16	..	..
400,000	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	112 —115	110 —113 xd	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —103	101 —103	102⅛	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	£	7 %	7 %	7 %	..	5⅛ — 5⅜	5⅛ — 5⅜	5 1/16	5 1/32	..
80,000	Do. do. 6 % Cum. Pref.	£	6 %	6 %	6 %	6 %	5⅜ — 6	5⅜ — 6	..	..	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	107 —109	107 —109	108½	107½	..
10,000	Folkestone, 1 to 10,000	£	..	5½%	5½%	4 %§	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	£	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
13,000	Hove, 1 to 13,000	£	..	8½%	8½%	8 %	8⅛ — 8⅜	8¼ — 8⅜	..	..	..
10,000	Do. New (£5 10s. paid)	£3	..	8½%	8½%	8 %	6 — 7	6 — 7	..	..	..
37,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	94 — 97	94 — 97	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	98 —100	98 —101	..	..	+ ½
21,000	Kensington and Knightsbridge Electric Ord.	£	10 %	12½%	12 %	10 %	10⅜ — 11⅜	10⅜ — 11¼	11¼	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	£	Nil	Nil	3 %	..	1⅜ — 2⅛	1⅜ — 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref...	£	6 %	6 %	6 %	6 %	4⅜ — 5⅛	5 — 5⅛	5⅛	5¼	+ ¼
374,295	Do. do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	97 —100 xd	97 —100	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	£	7½%	8⅓%	10 %	10 %§	9¼ — 10⅛	9¼ — 10½	10¼	..	+ ¼
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	£	4½%	4½%	4½%	4½%	5⅛ — 5⅜	5 1/16 — 5 1/8 xd	5 3/32	..	..
220,000	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	107 —111 xd	..	..	..
250,000	Do. 3¾ % Mort. Deben. Stock Redem.	Stock	3¾%	3¾%	3¾%	3¾%	97 — 99	96 — 98 xd	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	101 —103%	99 —101% xd	..	..	..
57,009	Newcastle-on-Tyne, 1 to 57,009	£	..	8 %	8 %	2½%§	8 — 8¼	8 — 8¼	..	..	..
17,991	Do. 57,010 to 75,000	£	..	..	..	2½%	8 — 8¼	8 — 8¼	..	..	..
57,009	Do. 5 % Pref., 1 to 57,009	£	..	5%	5	5 %	6¼ — 6⅜	6¼ — 6⅜	..	..	..
17,991	Do. 57,010 to 75,000	£	..	..	..	2½%	6¼ — 6⅜	6¼ — 6⅜	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	6 %	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort.Deb.	100	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	£	..	6½%	7 %	5 %§	6⅜ — 6⅝	6⅜ — 6⅝	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	100 —102	100 —102	100	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£	14½%	14½%	14½%	10%§	12⅜ — 13⅜	12⅛ — 13⅛	13	..	— ⅛
20,000	Do. do. 7 % Pref. 20,081 to 40,080	£	7 %	7 %	7 %	7 %§	8 — 9	7⅞ — 8⅞	..	..	— ½
150,000	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	98 —100	97 — 99 xd	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£	2½%	4 %	4 %	..	2 — 2½	2 — 2½	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	76 — 80	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	£	12½%	8 %	4 %	..	3 — 3½	3 — 3½	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	£	Nil	Nil	Nil	..	13/16 — 7/8	13/16 — 7/8	..	..	..
85,368	*(Late Blackheath and Greenwich* 7 % Pref.	£	Nil	7 %	7 %	7 %	1 5/16 — 1 7/16	1 5/16 — 1 7/16	1 11/32	..	..
148,292	*Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	105 —108	105 —108	..	..	..
50,000	Urban Electric Supply, Ord.	£	5 %	5 %	5 %	5 %	4¼ — 4⅜	4¼ — 4⅜	..	..	..
30,000	Do. do. 5 % Cum. Pref.	£	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	5⅛	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	104 —106	105 —107	106	..	+1
110,000	Westminster Electric Supply, Ord.	£	12 %	13½%	14 %	13 %§	11¼ — 12¼	11¼ — 12¼	12 1/16	11¾	..
28,151	Do do. 5 % Cum. Pref.	£	5 %	5 %	5 %	5 %	5⅜ — 6⅛	5⅜ — 6⅛ xd	..	..	..

Shares not officially quoted:—Mackay Companies, ord., 60—61. Pref. 75½—76½

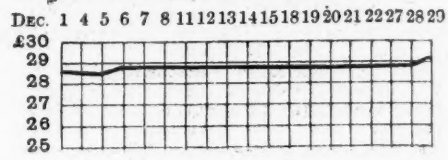
† Unless otherwise stated all shares are fully paid. § Interim dividends.

Bank rate of discount 4 per cent. (September 28th, 1905).

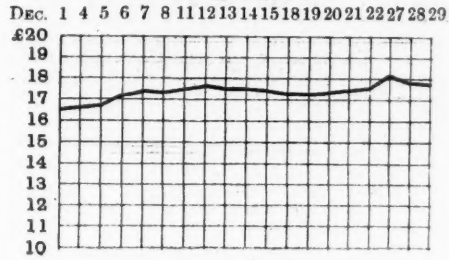
METAL MARKET.

Fluctuations in December, 1905.

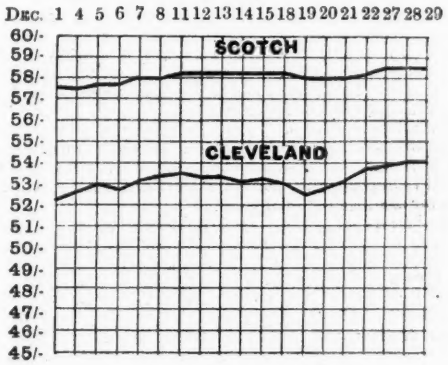
SPELTER (G.O.B's.)



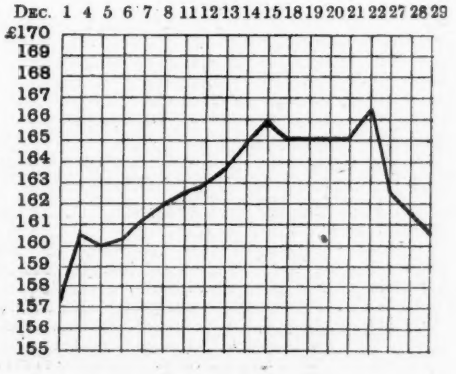
LEAD (ENGLISH)



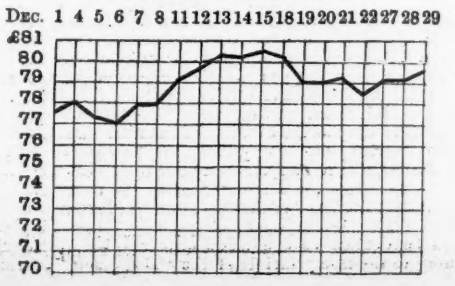
IRON.



TIN.



COPPER (G.M.B's.)



THE TIERNEY-MALONE POINT CONTROLLER.

On September 1st, in our description of the Electric Tramways Exhibition, we gave some interesting details of the Parr (Messrs. Hadfield) and Turner (Messrs. S. Dixon) automatic point controllers, and we understand that considerable use is being made of both already. Messrs. Brecknell, Munro & Rogers exhibited at the same time the Tierney-Malone point controller, but were unable to give us the information for which we asked until recently, owing to delay caused by certain preliminaries which were necessary before the device could be put fairly on the market.

On a complicated tramway network, the presence of point turners is considered generally to be indispensable if the quick service

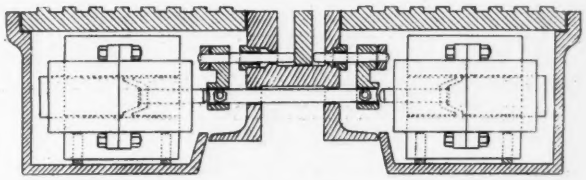


Fig. 1.

of cars is to be maintained. Boys and men are employed as a rule, but the desire to replace human by mechanical agencies is well evidenced by the presence of so many workable devices (to say nothing of the unworkable) designed to perform this end.

Naturally, the simpler such a mechanism is the more likely it is to sell, and—perhaps of still greater importance—to work. The

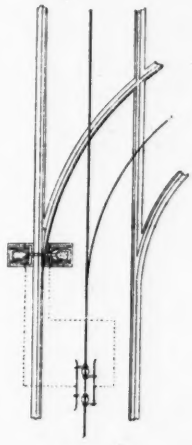


Fig. 2.

following short description of the latest point controller will give those who are interested in a matter in which economy is to the fore, some idea as to its ability to fill both the above requirements.

Fig. 1 shows the point-moving mechanism to consist simply of two solenoids and a frame carrying the push-bars. Either solenoid

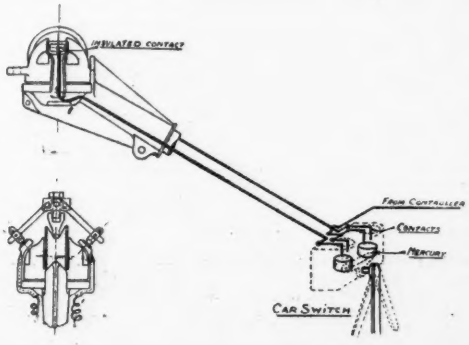


Fig. 4. Fig. 3.

is energised, according to the direction in which the driver has to take his car. It is evident that the windings can be protected absolutely from mechanical or atmospheric damage, and as they are not connected even by so much as a bolt with any part of the track, their removal and replacement can be effected in a moment. That is a feature of some value when the cleansing of the boxes is considered.

The solenoids derive their energy from the trolley wire through permanent cables, which are laid in one of the usual ways from the points to the nearest pole, and thence are carried up the pole to a pair of contacts which are attached to, but insulated from, the trolley wire at a convenient distance—say, 45 to 50 ft.—from the points, as shown in fig. 2.

Every trolley head is provided with supplementary contacts, which are insulated from the head and from each other. From them run insulated wires to a switch on each platform. Fig. 3 shows this arrangement of circuits in diagram; and fig. 4 gives plainly the relation between the overhead and trolley devices.

The contacts on the trolley are placed so that they clear frogs, switches and crossings.

If we may suggest improvements in detail, we should ask for the substitution of carbon contacts for mercury in the switch, and the addition of limited spring-controlled movement on the overhead contact arms.

POLYPHASE POWER MEASUREMENT: THE DOUBLE-WATTMETER METHOD.

It is interesting to note that in the double-wattmeter method of three-phase power measurement, we have a most simple indication of the power factor of the circuit in question, which is undeniably a great convenience in the parallel running of alternators. As is well known, the law of the method is that the sum of the readings of two wattmeters connected as in fig. 1, is equal to the power supplied or delivered—as the case may be—at all power factors (neglecting, of course, all errors in the instruments themselves). Now the ratio between these separate readings varies with the power factor, and in balanced systems is the same for similar power factors. It is proposed to give a simple graphical construction which enables the angle of lag to be obtained very easily from the readings of the wattmeters.

To make this the more clear, it will first be necessary to give the proof of the law mentioned above.

In fig. 2 let O A, O B, O C represent the current vectors (average values) in a balanced three-phase circuit, D E F being the vector triangle giving the pressures between its terminals (*a b c* in fig. 1). Wattmeter 1 is connected with its pressure coil across D F and current coil in O A; and wattmeter 2, with pressure coil across

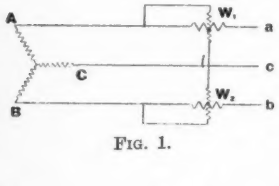


Fig. 1.

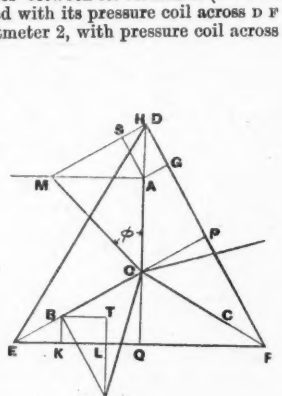


Fig. 2.

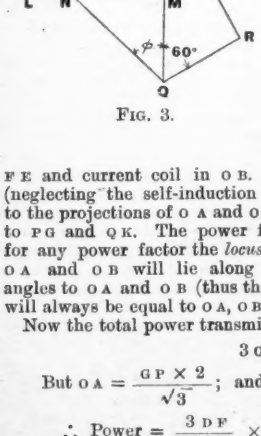


Fig. 3.

F E and current coil in O B. Hence the readings of the meters (neglecting the self-induction of the meters) will be proportional to the projections of O A and O B, on D F and F E respectively—*i.e.*, to P G and Q K. The power factor in the case given is unity, but for any power factor the *locus* of the limits of the current vectors O A and O B will lie along A M and B N respectively, at right angles to O A and O B (thus the effective component of the current will always be equal to O A, O B).

Now the total power transmitted is given by—

$$3\,OA \,.\, OD.$$

$$\text{But } OA = \frac{GP \times 2}{\sqrt{3}}; \text{ and } OD = \frac{DF}{2} \times \frac{2}{\sqrt{3}} = \frac{DF}{\sqrt{3}},$$

$$\therefore \text{ Power} = \frac{3\,DF}{\sqrt{3}} \times \frac{GP \times 2}{\sqrt{3}} = 2\,DF \times GP.$$

But from the symmetry of the figure we see that—

$$GP = KQ. \quad \text{Therefore Power} = GP \,.\, DF + KQ \,.\, DF.$$
$$= GP \,.\, DF + KQ \,.\, FE.$$

That is to say: For unity power factor the sum of the two wattmeter readings, which are equal, gives the power in the circuit.

Now let us introduce an angle of lag of $\phi°$. Then wattmeter 1 indicates *n*. P H kilowatts, and wattmeter 2 indicates *n*. L Q kilowatts. Draw A S parallel to D F and B T parallel to E F to meet N L produced in T. Now the triangles A M S and B N T are similar, hence—

$$AM : AS :: BN : BT.$$

Also the triangles O A M and O B N are similar.

Hence A M : O A :: B N : O B.

But O A = O B; therefore A M = B N and A S = B T.

Hence H G = K L. But K Q = K L + Q L, and P G = P H − H G. Therefore K Q + P G = K L + Q L + P H − H G.

But H G = K L. Therefore K Q + P G = Q L + P H.

Similarly it may be proved for any power factor that the sum of the readings of the two wattmeters gives the true power (neglecting the errors introduced by the intruments).

To determine the angle of lag or lead, having given the readings of the two wattmeters only, proceed as follows: Draw any right-angled triangle P Q R (fig. 3), having the angle P Q R 60° and the angle P R Q, 90°. From R P cut off R S proportional to the mean of the two readings, and again from R P cut off R T proportional to the reading on wattmeter 1. If the current is leading, this will be the lower of the two readings, but the same construction holds good. Now draw S M perpendicular to P R to cut P Q in M.

Draw M L perpendicular to P Q and T N perpendicular to P R to cut M L in N. Join N Q; then P Q N is the angle of lag (or lead) required.

The method given above is exceedingly handy in many cases where it is desirable to know the approximate power factor of a circuit, and the complication of a power factor meter is neither available nor desirable.

THE DIFFUSION OF LIGHT.

(*Concluded from Vol. 57, page 1048.*)

In the circumstances laid down at the beginning of this article, viz., the illumination of houses or streets, light is most commonly required to see by—we do not want to see it, or to make it act upon a photographic plate. Therefore, for practical purposes, the eye is quite properly used as the ultimate measuring instrument in the photometer, in spite of its optical defects and chromatic preferences. Now, the normal eye will pass two different sources of artificial light as of equal illuminating power, and then will frequently say that one lights a particular room or the like better than the other. That is a fact of universal experience, and is no optical illusion. That is what people probably have in mind when they assert that one light diffuses better than another; but, unless we are grievously mistaken, it has nothing whatever to do with diffusive power, in which all lights travelling for quite short distances through purely gaseous air are sensibly identical.

If we place a source of artificial light in a room furnished in the ordinary manner, but a room in which for simplicity we suppose that reflection is non-existent, we shall, of course, find that every object casts a shadow on the side away from the light. As the source of light is smaller, so the shadow cast by any particular object tends to be larger; but, and this is much more important, so also the shadow has more sharply-defined edges, and is more intense where it falls. As we increase the size of the light without altering its candle-power, the shadow cast by the same object is smaller over all, and, losing much of the sharpness of its outline, owing to the influence of the phenomenon known as irradiation, merges but slowly from light to dark, leaving a very much smaller portion of the room in perfect obscurity. When the radiant is small, the largeness of the shadows draws special attention to their presence, and the abruptness of the change from darkness to light makes the latter seem more brilliant than it is. By increasing the size of the radiant, these effects are softened, the lighting appears a little weaker, and the shadows less noticeable. In other words, there is greater uniformity of illumination throughout the room as between its lighted and its shaded parts; and it is this superior uniformity which, if we are not mistaken, unscientific lighting engineers are thinking about when they claim that a certain artificial light excels in diffusive power. But, of course, the illuminating power of a source of light considered as a function of the size of the glowing object is its intensity, or specific intensity; and hence it appears that a light "of good diffusive power" is simply one of low specific intensity, *i.e.*, one which is larger than others in its light-emitting surface for a given quantity of candle-power.

As we are dealing solely with the every-day conditions in which artificial lights are employed, it is necessary to remember that only the candle and some old-fashioned flat-flame gas burners are used without some globe or shade round them. When the globe is composed of plain colourless transparent glass, its effect upon the true source of light is so small in the present connection that it may be ignored; but when the globe is obscured, *i.e.*, is non-transparent—at least when the said globe is sufficiently obscured—the size of the light is virtually the size of the globe. Hence it follows that no source of light of considerable intensity should ever be employed with only a transparent glass round it; and also that an obscured globe should be as large as possible compatible with convenience, elegance and fairly even illumination over all its surface. If two different artificial lights of identical candle-power but as different in specific intensity as the candle itself and the filament of a glow lamp be inserted into two optically identical globes of properly obscured glass, and if first one and then the other be tested by the eye in a certain room, it will be found by the most practical man that the "diffusiveness" of the two lights is identical—because the specific intensity is the same. A properly obscured globe may perhaps be defined as one made of opal glass, prismatic glass according to the true principle of the "Holophane," or more than

one thickness of ground glass. In other words, "diffusiveness" is identical, or nearly so, with "illuminating effect," that quality of light which varies inversely with specific intensity, and, though most important of all, is seldom properly appreciated by lighting engineers or members of the general public. A light of good illuminating effect is one which gives the eye an impression of having a greater illuminating power than it has; a light of bad illuminating effect is one that creates the opposite impression. Since the illuminating effect for a given quantity of illumination issuing from a single source depends principally on the virtual size of the luminiferous object, *i.e.*, on the size of the glowing object as modified by any surrounding globes of the proper kind, illuminating effect, *alias* power of diffusion, is under human control even when the quantity of illumination is fixed; and a light of "excellent illuminating effect (or diffusiveness)" is simply one that is employed in an intelligent fashion.

We need hardly stop to mention that the argument already used shows that the larger the number of individual sources of artificial light put into a room, the better will the illuminating effect be, irrespective of, or out of proportion to, the total candle-power developed; because instead of each opaque object in the room casting one or two shadows in places where no other light falls, each object will cast a larger number of smaller shadows, and the shadows will be masked by the illumination coming from the other lighting units. For any given method of procuring artifical light, the light tends to be more expensive per unit of illumination as each single source is the weaker or the smaller; and therefore the multiplication of small lighting units makes for extravagance. On the other hand, a multiplication of units makes for better illuminating effect, and so for economy, because a given quantity of illuminating effect (if we only had an objective way of measuring it) is obtained from a smaller amount of candle-power when the units are many than when they are few. Obscured glass, too, wastes light from the photometrist's point of view, but may save rather than waste illuminating effect. All these matters are most elementary, and well known. We do not feel sure whether it is commoner for them to be known or to be ignored in practice.

There is one other aspect of the present question that is also habitually ignored by lighting engineers, and we cannot but feel that they are greatly to blame for their action. In a previous paragraph we assumed the existence of a room in which reflected light does not exist. There is, of course, no such room known to mankind outside the laboratory; but the tendency of modern times is to approach it. The presence of reflected light in a room does not in the least affect the correctness of what we have already stated; all that it does, if present in sufficient quantity, is to help in the conversion (if the expression may be permitted) of illuminating power into illuminating effect. A room, therefore, rich in reflective power reduces the cost of developing artificial light to a useful extent in it, and may even cause one source of light to produce the effect of two. We have only to take up any periodical catering more particularly for ladies—papers which tell their readers how to make a house "beautiful," artistic, or the like—or even some of the more professional journals studied by architects and decorators, to see the disastrous notions that are constantly being impressed upon the lay community. They are urged, week in week out, to have their rooms painted in dark colours, papered with rough, dark papers, ceiled with wood or non-reflective surfaces, upholstered with dark materials, filled with dark furniture. They are told that this is the fashion, that it is artistic, that no self-respecting person can live in a dining room decorated in light shades, that lightness is only permissible in the comparatively unused drawing room. In plain language, they are taught that the perfect house is one filled with (genuine or false) curious old objects properly to be found in museums; that it must be elegant. Almost everything that tends to make it lighter is tabooed; everything that helps to make reading, writing or seeing generally a greater strain on the eyesight is lauded. It is curious, too, that this goes on at a time when physicians are preaching the "open air" and the "sun bath" cure for various diseases. We consider this so serious a matter that lighting engineers ought to preach an opposite crusade. They may be doing so as individuals, for aught we can tell, but that is not enough. An organised attempt ought to be made to counteract the harm being done to the community by the spread of the pernicious doctrines we have referred to, which are promulgated in nearly all the "home journals" we have ever seen. On a cash basis, present decorative notions may be good for the lighting industry, because much more light is needed thoroughly to illuminate a dark room than a bright one; but the illuminating effect in the former can never be good except at prohibitive cost, and the result of living in a dark house is enormously to exaggerate the necessary expense of any system of procuring artificial light. Moreover, the almost inevitable attempts to economise may lead to eye work being carried out in a deficient light; and the resulting eye strain will be attributed by the layman, not to the character of his furnishing arrangements, but to some specifically injurious property in the light he uses, all the more to be dreaded because its nature is unknown.

Enfield Electric Lighting.—A site having now been obtained for erecting the station, the North Metropolitan Electric Power Distribution Co. has informed the U.D.C. that it has authorised the laying of mains forthwith.

PROCEEDINGS OF INSTITUTIONS.

Two New Electrolytic Meters.

By S. H. Holden.

(*Abstract of paper read before the* Institution of Electrical Engineers *at Birmingham, December 13th*, 1905.)

The two meters to be described are each developed from the oldest and simplest form of electrolytic meter, viz., the gas voltameter employed by Faraday, but one belongs to the unshunted and the other to the shunted class.

In order to overcome the difficulties of gas measurement Bunsen suggested that the electrolyte should be weighed and its loss of weight used as a measure instead of the volume of the evolved gases. Fig. 1 shows in diagrammatic form the working parts of a meter constructed on what may be called Bunsen's plan. A is a

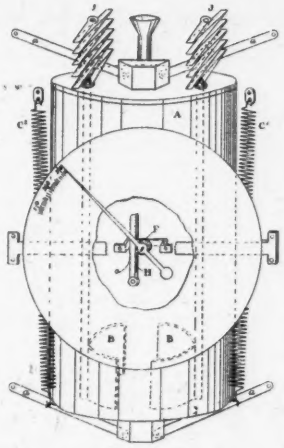


Fig. 1.

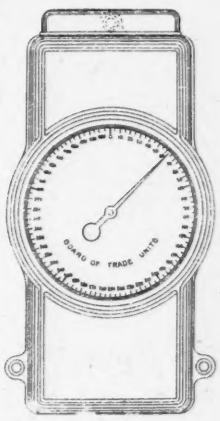


Fig. 1a.

thin iron vessel with an ebonite lid. Within this vessel is a solution of caustic soda and a pair of sheet-nickel electrodes, B B. A small hole is left in the lid for the escape of gas. The whole vessel is supported in a case, upon four springs, two only of which are shown, marked C^2. Attached to the front of the iron vessel is a light rack, H, working into a pinion, F. The pinion carries a hand or pointer moving over a graduated dial attached to the case. Part of this dial is broken away to show the gearing more clearly. Guide levers *a a a a* attached to the case and to the top and bottom of the iron vessel, ensure its remaining central. Light flat springs, J J, carry the current from the fixed terminals to the electrodes. The meter shown is intended for a current of 5 amperes, and the capacity of the vessel is such that current equivalent to 400 units at 200 volts may be registered before the meter requires refilling. The solid caustic soda to form the electrolyte is placed in the vessel A, as soon as the meter is made; it is therefore only necessary to fill the meter with water when required for use. Since the electrolysis of a fixed weight of water corresponds to 1 unit, the accuracy of the meter may be ascertained by placing upon the vessel a brass weight which is equivalent to the amount of water that would be electrolysed by, say, 100 units at the required voltage, and then seeing that the pointer moves over 100 divisions on the scale. Calibration of the meter in the first instance may be effected either by varying the strength of the springs or by using dials having fewer or more divisions in the circle, or by varying the number of teeth in the pinion. When a fairly large number of units has been registered, say 300, the reading is noted, and water again poured in until the hand stands at zero on the dial; registration can then go on a before. The actual weight of the vessel, when filled, is about 4½ lb. and about 1½ lb. of water may be removed by electrolysis befor refilling becomes necessary. This would correspond to a total registration of 400 or 500 units. Fig. 1a shows the complete meter.

A meter such as the one just described is subject to the limitations and defects of its class, viz., relatively large fall of potential at all loads, considerable bulk, and the necessity of occasional refilling. On the other hand, it is accurate, simple, and easily handled. It also fulfils an object which was held in view when designing it, viz., the production of an electrolytic meter which contained no glassware and required no handling of chemicals. A number of meters of this kind have been made, and have worked satisfactorily as regards registration over a considerable period, and the dial hands have also remained perfectly stationary during a long period of rest, showing that no change in the electrolyte or springs took place.

The previous meter possessed the great practical advantages of a simple electrolytic process, and one for which the materials of electrolyte and electrodes may readily be obtained in a state of purity. An attempt was therefore made to enable such a meter to be shunted without at the same time introducing fatal complications. For a meter to be shunted, the first condition is that the current passing through it is exactly proportional to the difference of potential between its terminal electrodes; for this is the law governing the current passing through the metallic conductor con-

stituting the shunt. In order that a gas voltameter may conform to this rule it is necessary that gas should dissolve at one electrode and reappear at the other. A solid hydrogen anode cannot be made, but the equivalent of one may be obtained by using a mass of spongy platinum saturated with hydrogen; and if this anode is only partly immersed in the electrolyte and the remainder is exposed to an atmosphere of hydrogen, sufficient gas will be absorbed and transfused to replace that which is dissolved away. Fig. 2 shows the arrangement in its simplest form. A and C are electrodes of platinum in dilute sulphuric acid contained in the vessel S. They are thickly coated with platinum black, and are only partly immersed. Above the electrodes is a sealed space, H, full of hydrogen gas. In such an arrangement the smallest difference of potential (say $\frac{1}{100}$ of a volt) will cause a steady and continuous current to pass between the electrodes; hydrogen is evolved at the cathode, but no oxygen at the anode. Instead, the

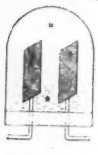


FIG. 2.

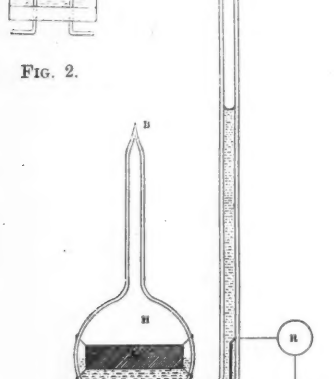


FIG. 3.

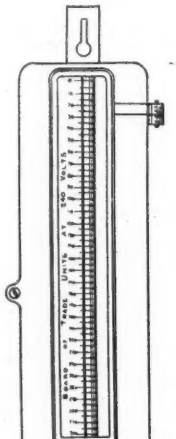


FIG. 4.

exposed surface of the anode absorbs hydrogen from the store above it, which combines with the oxygen as fast as the latter is produced. This arrangement is therefore comparable to a copper or silver voltameter in which the same metal is dissolved at the anode as is deposited at the cathode.

It will be seen that (within limits) it is possible to pass a current continually through an electrolytic vessel arranged as above, without effecting any alteration in the volume or disposition of the electrolyte, the enclosed gas, or the electrodes; it may, in fact, be hermetically sealed up and used for an indefinite time.

If the electrolytic vessel thus sealed up is divided into two compartments, so that the gas evolved at the cathode does not immediately return to the general store, then the volume of the former may be used as a measure of the current passed, and being sealed up its volume is not affected by changes of external pressure or temperature. After a certain amount of gas had been thus transferred from the store to the measuring tube, and the latter had become full, it would be necessary to return this gas to the store. This can be done by tilting the tube down, by which process it is re-filled with liquid and ready for a fresh start.

As explained above, the current passing through a meter of this type is proportional to the difference of potential between its electrodes. This property enables the meter to be shunted; a very small portion of the total current to be metered need be passed through it, and the amount of gas evolved during one or two years' service can be reduced to a quantity easily contained and read off in a graduated tube.

The volume of gas settled upon for this purpose is about $1\frac{1}{2}$ cb. in., and is measured in a graduated glass tube $\frac{5}{16}$ in. internal diameter and 15 in. long. The scale is graduated into 300 divisions 1 millimetre apart—large enough to be read easily—and each division corresponds to about 5 ampere-hours passing through the meter; that is to say, one Board of Trade unit at 200 volts. To produce this volume of gas, for the passage of 300 units only one fifty-thousandth of the total current passes through the electrolyte, and an area of about 1 sq. in. of platinum anode is sufficient. The fall of pressure through the shunt of the meter is 1 volt at full load, so a resistance coil of 10,000 ohms is included in series with the electrolyte. This coil has the same temperature coefficient as the shunt, so that no temperature error exists from this cause. The added resistance being so large, the resistance of the electrolyte is quite negligible.

Fig. 3 shows diagrammatically the essential parts of the meter; it consists of a vertical tube with bulb attached. C is the cathode—a platinum wire; A is the anode of sheet platinum, both coated with platinum black. S is the electrolyte, and H the store of hydrogen. R is the resistance coil, equal to about 10,000 ohms. T the shunt, which in a 5-ampere meter has a resistance of ·2 ohm.

To start the meter, it is held with the tube nearly horizontal and below the bulb. All the gas then collects in the bulb, while the tube fills with electrolyte, which remains in it after it is restored to the vertical position for use. When a current is passed through the shunt, a steady fine stream of gas bubbles rises from the cathode, gradually replacing the liquid in the tube.

No electrolyte gives such good results as a 10 per cent. solution of sulphuric acid. Phosphoric acid is, perhaps, the next best. It is remarkable that the material of the cathode is almost as important as the anode, only platinum well coated with platinum black being satisfactory.

Fig. 4 is a front view of a complete meter with the case closed. Almost the entire height of the meter is available for the scale.

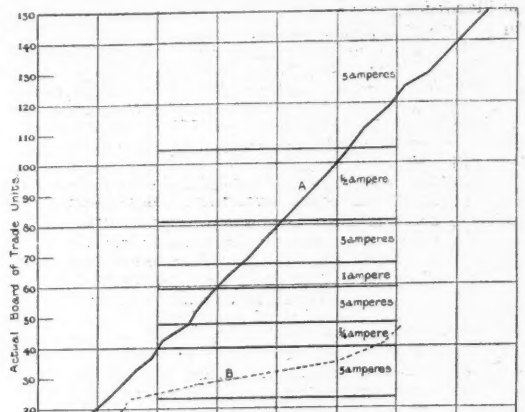


FIG. 5.

Fig. 5 shows curves taken over long runs, the electrolytic meters being tested against a motor meter, whose accuracy was checked for each load. The ordinates represent the actual ampere-hours passed through the meters, and the abscissæ the amounts registered. The space is divided by horizontal lines showing the actual current passing. It will be seen that these meters are capable of giving very good results, as shown by curve A. In fig. 6 the curve is drawn in a more usual manner, the ordinates being percentage errors and

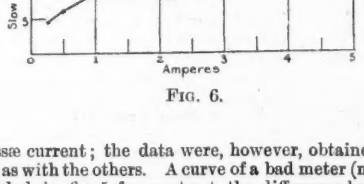


FIG. 6.

the abscissæ current; the data were, however, obtained from long-time tests as with the others. A curve of a bad meter (marked B) has been included in fig. 5 for contrast, the difference being produced by the use of a polished cathode in the bad one.

So far as the author is aware, no use has hitherto been made of an electrolytic process involving the continuous absorption and solution of gas at one electrode, and its evolution at the other. As the process, therefore, seems to be novel, it is hoped that uses may be found for it in other directions besides electricity meters.

The Chairman, Prof. THRELFALL, asked whether it might not be possible for the readings to be falsified if one limb was at a higher temperature than the other, for it appeared that in this case the concentration of the hydrogen solution would be different in the two limbs, and there might be a continuous solution of the free gas on the colder, and a corresponding evolution on the warmer side. He also asked whether there was not a temperature coefficient of the resilience of the springs in the first form ofmeter described, which might lead to temperature error.

Mr. R. A. CHATTOCK thought the second meter was a very interesting departure, and would probably prove successful in practice. He would like to know if it was necessary to coat the electrodes with a certain definite quantity of platinum black. Did the electrodes remain for long periods without alteration, or was there any tendency, say, for the platinum black to peel off? What would be the effect of a short circuit on the meter? Would there be any liability for the tube to burst on account of the rapid evolution of gas?

In reply, Mr. HOLDEN said that the points raised by the Chairman and Mr. Chattock had had his attention. There was no such transfer of hydrogen. He had also proved that there was no practical error in either meter due to change of temperature. An advantage of the first meter was that the use of a circular dial enabled a much longer scale to be used than in other types of electrolytic meters. He treated the platinum electrodes with a good thick coat of platinum black, but of no definite amount. So

long as the platinum itself was entirely covered, the amount of platinum black did not affect the accuracy of the meter. He had now had meters running continuously for many months without showing any falling off in accuracy. As regards a short circuit, he pointed out that the meters which he was exhibiting to the meeting were running with a current through the electrolyte of 300 times the normal value. He was running them with the resistance short-circuited, in order that they might see the evolution of gas, which, under ordinary circumstances, was not easily detected. It was evident that no harm would be done by a short circuit.

Secondary Cells.

By G. D. Aspinall Parr, M.Sc.

(*Abstract of Paper read before the* Institution of Electrical Engineers *at Leeds, December 13th, 1905.*)

All manufacturers are agreed that impurities are injurious to secondary cells, but the exact maximum amount of each that is admissible is indefinite.

Plates of the Planté type are given porosity in the course of manufacture by treatment in some oxidising or pickling solution containing nitrogen compounds, but all traces of these compounds are eliminated before the plates leave the works. The main source of trouble is impurity of the electrolyte, due either to the acid or to the water.

It is best to use "brimstone" acid for storage batteries, as this is usually free from arsenic. Rain water is not necessarily pure, as it may contain over 100 parts per million of foreign matter, and water from town mains is deleterious. Some impurities cause local action and loss of charge, which are about three times as great with acid at 1,300 sp. gr. as at 1,170.

The use of distilled water in the electrolyte is imperative; but condensed steam from the boilers must not be employed. The electrolyte must be free from arsenic, nitrogen compounds, sulphuretted hydrogen, sulphurous acid, and organic matter, and must not contain more than traces of hydrochloric acid and iron. Ammonia, as shown by Mr. R. W. Vicarey, is exceedingly harmful.

The author has commenced a series of tests with a view to determining the maximum amount of any given impurity which may be present in a cell without seriously affecting its capacity and efficiency. Eleven of the commonest impurities in sulphuric acid and water have been chosen, in amounts at least equal to the maximum ever found in ordinary water and ordinary purified commercial acid. One cell contains pure electrolyte, while each of the others contains a known proportion of a single impurity. So far, 22 charges and discharges have been taken on each cell, but as the tests have not yet been completed, the comparative results are not available.

The author recently carried out an extensive series of tests on cells of ordinary type, of 300 ampere-hours, capacity, charged and discharged at varying rates. The capacity (output) varied between 134 ampere-hours and 247 watt-hours when discharging in 1 hour, to 290 ampere-hours and 574 watt-hours when discharging in 10 hours, the corresponding efficiencies being 80 and 91·2 per cent. (quantity), 59·7 and 75·1 per cent. (energy). The charging rate adopted had little or no effect on the output at a given discharging rate.

An Electric Accelerometer.

By R. B. Owens, M.Can.Soc.C.E.

(*Paper read before the* Canadian Society of Civil Engineers, *Electrical Section, November 2nd*, 1905.)

The advent of the electric motor as a competitor of the steam engine, especially in the traction field, has given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train-mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train-mile, car-mile, nor ton-mile suffices, even when coupled with a speed factor as a basis of estimation and analysis, and when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate, and realiable means of measuring acceleration is urgently demanded—a means at least comparable in simplicity and accuracy with those employed in the measuring of the quantities of which it is the second and first differential with respect to time. The measurement of length is familiar to all. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the piece whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant coefficients as shown in fig. 1.

S is the shaft whose velocity is to be measured. C is a mechanical coupler. A is the armature of a small permanent magnet or constantly excited continuous current dynamo, wound so as to have a negligible reaction within the limits of its use. R is a variable non-inductive resistance, and I is a zero centre D.C. ammeter. The reading of I will be proportional to the speed of S, and by adjusting R can be calibrated in revolutions per minute, feet per second, or miles per hour as desired. As the current through I is proportional to speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting in the circuit with I a transformer T with its secondary connected, for purposes of adjustment, through a non-inductive resistance R_1 to a zero centre D.C. voltmeter V (see fig. 2). The reading of the voltmeter V will then be proportional to the acceleration, positive or negative, of the shaft S.

Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio, as the secondary

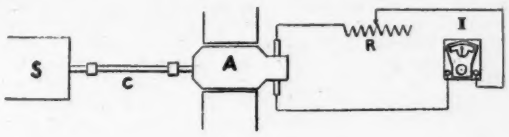


Fig. 1.

induced voltage is necessarily small and the voltmeter V must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature A at different constant speeds as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature A by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time. With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line, whose slope will be constant and equal to the acceleration and to the constant reading of the voltmeter to within a constant.

In some tests made in the writer's laboratory not long ago, A (see again fig. 2) was the armature of a small low voltage separately excited D.C. generator; S the shaft of a 3 H.P., separately excited D.C. motor, to whose armature by a potentiometer arrangement a

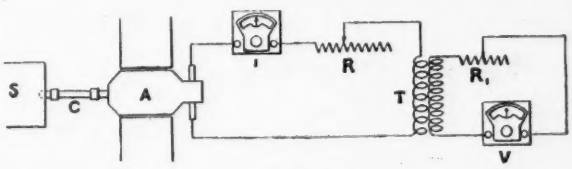


Fig. 2.

steadily increasing or decreasing voltage could be applied; I and V Weston ammeter and millivoltmeter, and T a small lighting transformer with a transformation ratio of 20; and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston D.C. ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work both steam and electric, and is applicable, of course, in many other connections.

Waste Gases and Electricity Generation.

"The Generation of Electricity by the Waste Gases from Modern Coke Ovens" was the subject of a paper read by Mr. G. J. Hooghwinkel, M.I.E.E., at the last meeting of the Manchester Geological and Mining Society. The chair was occupied by Mr. Henry Hall, H.M. Inspector of Mines. After drawing attention to the immense waste of energy which is going on from day to day in iron and steel works, the writer said the application of blast furnace gases to the production of power, and electrical power in particular, was an established fact in this country, and its growth would be witnessed during the next decade. It was pretty certain to keep pace with the urgent remodelling and redesigning of iron and steel works in the near future. The experiments of Mr. B. H. Twaite in this country opened the way, but the first large undertakings of this kind were established in Germany, and most of the ironworks, both in that country and in the United States, were equipped with electric power stations deriving their power from the gases of the blast furnaces, while many of the powerful blower-engines were driven by the same agent. The writer had taken part in the design and erection of the gas plant at the Ilseder iron works, supplying also the necessary power to the Peine rolling mills, near Hanover. The entire steel works and rolling mills at Peine were driven by electricity generated from waste blast-furnace gases, a striking example of the economy effected by modern practical applications. The same advantages as regards the supply of power for driving the mechanical appliances of a modern coking plant, with washing and cleaning plant near by, and even the plant at the pits, might be derived by using the surplus gases from coke ovens direct in gas engines. The question was one of public utility and economy. Such gases would provide the country with a source of cheap power comparable to the water-power used in Canada and elsewhere. He had found in many cases that the cost per unit in coke-gas power stations of medium size was about 0·1d. to 0·2d. The production of cheap power at collieries was a question gaining in importance every day proportionately to the drop in the price of the saleable article and the increased depth of the pits. The firing

of steam-boilers by means of small coal at the pit was an expensive, and, if no rubbish and refuse from the washeries were available, a very wasteful process, having regard to the low efficiency of the boilers. Even taking the value of this small coal at 4s. per ton at the pit's mouth, the saving of coal by using gas engines was a substantial item. Every modern colliery should, therefore, either burn its rubbish and waste in gas producers, or else compress and coke it in by-product ovens, using the gases obtained in both processes for generating electrical power by means of gas engines. The amount of power to be derived from a battery of 80 ovens of modern type, coking a charge of 7 tons in 32 hours, and using coke of a medium percentage of volatile matter, giving off about 7,000 cb. ft. of gas per ton per hour, or in all 122,500 cb. ft. per hour, would be as follows:—If the ovens used 70 per cent. of the gases for heating the flues, there should remain about 36,000 cb. ft. for power, and taking a consumption of 75 cb. ft. per I.H.P.-hour, about 1,500 I.H.P. should be available, or nearly 20 I.H.P. per oven. This amount varied, of course, with the coal and the type of oven; and he knew of cases where the power was nearly 30 I.H.P. per oven. Discussing the different types of gas engines available, he described a typical large coke oven engine on the four-cycle principle.

Destructors and their By-products.

By F. L. Watson.

(Institution of Electrical Engineers' *Discussion at Leeds, November 23rd*, 1905.)

Mr. Emmott said regarding Mr. Watson's ideal balance-sheet, although the same had not been realised in practice, he saw no reason why it should not be done with towns having a population of 120,000 inhabitants, but in towns of a smaller size, say, 25,000 to 30,000 inhabitants, the by-products so utilised would not pay for putting down the plant necessary for brick making, as there would not be sufficient clinker. He did not agree with the author in condemning front feed, as he had found this most efficient for small plants where a reasonably steady head of steam had to be maintained. Regarding a combination of refuse destructor and electricity stations, it was wise to remember that the boiler was a necessity in cooling the flue gases before passing to the chimney, and therefore the small size of boiler which one found in some installations was not an efficient combination, especially if any use was to be made of the steam. He advocated a size of 30 ft. × 8 ft., and a working pressure of 200 lb. per sq. in. As to the management of the destructor in a combined station, to ensure efficiency this must be entirely in the hands of the resident electrical engineer, the Sanitary Committee having no responsibility or control beyond delivering the refuse and removing the clinker. He had no difficulty in getting 60 units per ton of refuse in every-day working.

Mr. Silcock quite agreed with the author of the paper that the front feed was not a satisfactory method of charging the furnaces. He saw no objection to the utilisation of as much steam as possible, but this must not be done at the expense of efficiency in destroying the refuse in the most perfect and sanitary manner. The making of bricks, the driving of tramcars or power conversion in other ways, would, in his view, be more suitable than electric lighting. For foundations for roads or filling up land requiring to be levelled, clinkers formed an admirable material, and a large demand always existed for destructor refuse for the purpose named, but, of course, at a price which would not compare with the results shown upon the ideal balance-sheet presented by the author of the paper.

Mr. A. S. Blackman believed that in many cases the legitimate object of a destructor was lost sight of, and the destructor makers were striving after results in the way of operating costs which they could never attain, and which would never be justified, otherwise than experimentally. In connection with the Sunbridge Road destructor at Bradford, the people who had charge of the destructor cells had, in their efforts to keep up steam to supply the electricity department, to take the refuse from the cells before it was sufficiently consumed, and, as a matter of fact, he had that afternoon had some discharged matter from the cells analysed, and found it contained 31 per cent. of combustible material. With reference to the balance-sheet, Mr. Blackman said the figures were altogether erroneous. He had been running the electricity plant at Sunbridge Road for 24 hours a day, in an endeavour to see what could be got from it, and the best they had been able to do was 21,000 units per week. It was impossible to do very much more than that, unless they either put in a battery of altogether abnormal proportions or reverted to some system of thermal storage. It was stated that 1s. 6d. per ton for the steam was a reasonable figure to ask, which worked out at about ·35d. per unit, and that was the figure which the department he was chiefly concerned with was called upon to pay, whereas the coal at the Valley Road works was coming out at ·17d. per unit generated. At Sunbridge Road an outlay of £29 per kilowatt had to be made, and it was perfectly easy to put down a main generating station, inclusive of steam raising and coal conveying plant, at well under £25 per kilowatt installed. Speaking solely from the point of the electricity department, they were out of pocket on the Sunbridge Road plant to the extent of about £1,000 a year, in round figures.

Mr. S. D. Schofield said that if the destructor was attached to the electricity works, the probability was that no less plant would be required in the electricity works than if there were no destructor. In winter, particularly, the supply of refuse was very uncertain, and in the case of a heavy fall of snow, the supply of refuse might be cut off altogether for three or four days. Consequently, they required sufficient plant to deal with the peak loads, independently of the destructor. He agreed that 1s. 6d. was too high a figure to pay for the steam generated from a ton of refuse. If 9d. or 10d. per ton were allowed, it was quite a top figure, and really more than the steam was worth.

Mr. Call said the Hammerton Street installation had a capacity of 120 tons of refuse per 24 hours, and something like 300 H.P. was obtained for the electric lighting of the shops and stables belonging to the works and cleansing departments, for the running of the fish manure plant, mortar mills, driving the workshops, crushing and screening the clinker for the manufacture of concrete flags and mortar.

Mr. Harris said that from careful observation he considered the front feed arrangement possessed advantages over every other method of firing, particularly where maximum steam generation was required.

Mr. P. Rosling thought that 10 to 15 per cent. would be nearer the proper figure than 6 per cent. only for capital charges. If the capital charges were increased by 5 per cent. the yearly cost would be increased by another £1,000, and if they reduced the value of the steam to a more reasonable figure of, say, 9d. per ton, the balance-sheet would show a loss of some £200, instead of a profit of over £2,000.

Mr. T. Roles agreed with the last speaker's remarks respecting the sum shown on the balance-sheet for interest and sinking fund. Nothing was allowed for depreciation. The price of coal mentioned by the author was considerably too high. At the electricity works at Fulham and Shoreditch, both working in connection with refuse destructors, the fuel cost something like ·85d. per unit sold, whereas at Poplar the fuel came out at ·5d. per unit sold.

Mr. Pickersgill said that when destructors supplied steam to an electricity works they should only be paid such amount for steam as equalled the saving on the actual cost of coal. The greatest objection to the destructor was the amount of dust that got into the engine room and on the commutators, gearing, &c.

Mr. W. Mortimore, in a communication, supported the front feed on the score of cleanliness and efficiency. He advocated heating the air on the regenerative system by waste heat, in preference to the use of side air boxes.

Mr. F. L. Watson replied at considerable length to the points raised, and quoted some figures received from Mr. A. J. Fuller, borough electrical engineer of Fulham, dealing with a continuous run on the Fulham destructor from October 9th at 11.30 a.m. to October 22nd at 8.30 p.m., 1905. This test was carried out to show the effect of a re-arrangement of the boiler settings which Mr. Fuller had carried out. The consumption of refuse per cell per 24 hours was 10·9 tons, the evaporation per pound of refuse calculated from and at 212° F. was 1·53 lb., or 17½ per cent. better than on the original test; the mean temperature of gases in the combustion chamber was 1,900° F., and the temperature of gases leaving the boilers 670° F. Economisers were used, heated by the waste gases after passing the boilers. The later and longer trial gave better results all round than the original trial, doubtless largely due to the alteration in the boiler setting, by which the boilers were brought nearer to their work and losses by radiation and air leakage reduced. At Fulham the steam was used fully throughout the day, though by no means all in the electricity works.

THE OVERLOAD AND REVERSE CURRENT RELAY.

[COMMUNICATED.]

(*Concluded from Vol. 57, page* 1051.)

The Reverse-Current Relay.—In order to protect machinery from a reversal of current, the reverse-current relay was put on the market. A reversal of current can take place in the following cases:—

1. When several central stations work in parallel.
2. When several generators in one central station work in parallel.
3. When feeder sub-stations are fed by two or more incoming feeders.
4. When a synchronous motor drives a generator, the latter working in parallel with other similar units.
5. When several rotary converters work in parallel with one another.

In all the above cases, reverse-current relays ought to be installed. The reverse-current instrument is based on the same principle as the overload relay, but slightly differs in construction. Instead of one, we here have two alternating current magnets (fig. 5), one, the current coil, being energised from a current transformer, while the other, the pressure coil, is supplied from the secondaries of two pressure transformers connected to different phases. The relay, as will be seen from the wiring diagram, fig. 6, is connected in the usual wattmeter fashion. The field produced by the pressure coil will practically be in quadrature with the field set up by the current coil. It follows, therefore, that

the copper ring phase-splitting device, as used in connection with the overload instrument, is here superfluous, a rotating field resulting from the fluxes set up by the two coils. The instrument does not claim to be a time-limit apparatus, nor is this wanted, as the relay has to operate the moment a reversal takes place, irrespective of the strength of the said reversal.

The reverse relay works in the following manner: As long as the current in the circuit flows in the right direction, the disk is slightly turned backwards until a pin projecting from this disk knocks dead up against the fixed spring. In the event of a reversal occurring, the disk immediately

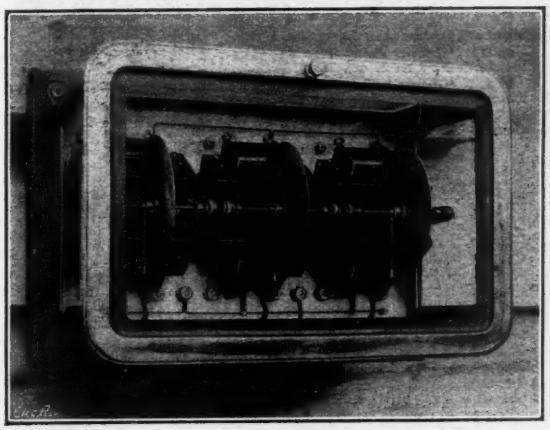
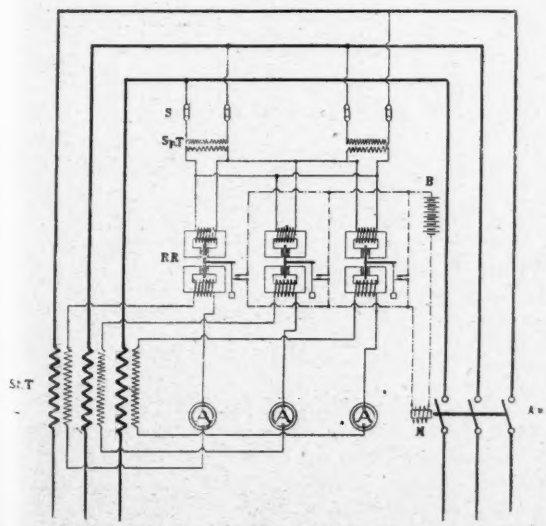


Fig. 5.—Reverse-Current Relay.

makes a whole revolution forwards, the projecting stud presses the contact springs together, and the tripping circuit is completed. The wiring diagram of the reverse relay is also very simple, although slightly more complicated than the overload relay diagram. The tripping coil may, in this case also, be fed from a battery or any other continuous current source.

This instrument is also made in single, double, or three-pole patterns for single, two, or three-phase circuits respectively.

In certain cases, with rotary converters, for instance, it is advisable to install an overload and reverse relay on one and



A, ammeter; B, battery; M, tripping coil; R R, reverse-current relays; S, fuse; SpT, pressure transformer; StT, current transformer; Au, main switch.

Fig. 6.—Diagram of Connections.

the same circuit. When this is done, the current coils of the overload and reverse instruments are connected to the same current transformer.

In setting the various relays on a system, a certain amount of discretion must be used in adjusting them for time. Care should be taken that the feeder circuit relays always operate before the generator circuit relays. The reverse-current relay ought to, and does in this case, open before any of the others.

Special care has been devoted to the construction of the instrument, and all parts which are likely to get out of order in time, such as spiral springs, &c., have been avoided. The disk revolves in jewelled bearings, and is very carefully balanced. All contacts are platinum tipped or made of silver or carbon. The whole apparatus bears the stamp of a high finish, and is an ornament to any board. The instruments can either be mounted direct on or let in flush with the panel.

THE ELECTRICAL FROISSART CHRONICLES.

(With some apologies to Sir John, and more to "F. C. G.")

By IBID.

V.—Concerning Precedents.

In all countries and times it hath been customary for men to be divided into sorts or setts, for mutual defence against their foes and friends. Even so may ye hear two that sit at meat together declare, the one "I am for Burgoyne," and the other "and I for Bordeaux"; but now without bitterness or mistrust, as they would in the old days. For the better regulation of the one sett, some other sett maketh laws and rules, sith they know not what is good for them; and, for the making of these laws they have a very simple plan, which I will tell you. Considering together, the great and wise say among themselves: "we may not, save by sorcery, foretell the future, wherefore we must build our laws on that which is past, that we know of." And this they call "A Precedent," and having found a precedent, they are comforted, for is it not easier to follow a road that is made, than to hew a new one through a vested interest? Thus changes are looked upon as mischievous, and to be avoided.

With the Guild of the Electriks it is the same, to all seeming. For though they are, as I esteem, the most changeful and uneasy people in all Christendom, always seeking a new thing, to outward appearance they follow the customs of other Guilds and Clubs. So, every year, they choose among themselves one to hold, or be, their Precedent, as hath been done formerly.

As I guess, the office of this their Precedent is to go before, or show them in what direction to turn their steps; but that he hath also some secret office or dominion may be seen, from that they call the day of his first presiding "Day of the Lord Mare," which is, as can easily be seen, "Day of the Lord Maritime, or of the Sea," and celebrate it with notable procession and rejoicing.

Now, on commencing to his rule and leadership, the Precedent maketh an exhortation of such nature as shall be evident to the Inner Circle of the Guild, though it be as Greek to them that are in the outer (or gas-lit) darkness. For the better ensuring of precedence on this occasion is a law made that they who desire to learn only shall stand on the outer limits of the Hall of Audience, and they that have learned shall sit in the front thereof: even as in other displays, they that would be seen place themselves before those who have come to look on; this is a very old custom.

In the year of which I write was chosen as Precedent of the Guild a notable knight, Sir John de St. Gaveyn's le Grand, whose arms are dexter, a Wheatstone Bridge, P.O. Pattern, or on ebonite displayed; sinister, a double-petticoated insulator porcelain, erect on a mast sable; surmounted by dexter, a submarine cable dormant under a sea gules, insulated as per specification; sinister, a telephone receiver intact expectant; crest, a relay; supporters, two British taxpayers irate and resplendent, clothed in conscious virtue cut semi-recent. Motto: *Sic transit vox populi.*

(For since the days of the Megatherium and the Athenæum and other great things slow in movement, when the Electrics were called the Sons of Mercury, the Sky-wirers are held much in honour among them.)

The Exhortation of this Precedent was, like all the doings of the Electriks, a matter to marvel at; as much for the learning and research therein displayed, as for the strength

and endurance of one who can deliver it in a short space. Moreover, nothing therein but had its purpose; for, throughout its length should ye hear no such fair flowers of speech as: "When I and the late Lord Apollo Belgraviere were at Croydonsberg," for which, indeed, the mind of the listener longeth, but, alas, *vita brevis est*. So, in the short space of one hour and a quarter, did the Precedent, with unfaltering voice set forth the whole matter. Firstly, how that, without the permission of the Electriks shall no carriage travel on iron; but, by their assistance is its course much hastened. And, of this, it is told me that, on one road, where the carriages be noted more for stopping than moving, aid hath been sought of the Electricks, so that shortly men may mount on a train (as they call it) with mind secure that it belongeth not to the day before; for the arrears be so great that oft-times there is danger that what thou thinkest shall bear thee home be instead an early Miocene train oft-baffled in its course; which, on mounting therein, by its aspect thou dost perceive.

But in this discourse was treated more of the permission to proceed than of the push behind; and i'faith, 'tis more oft the one lacketh than the other. And it was shown how one train may by his weight send a message to the other; a thing very marvellous, and, meseems, not without danger; for, if these machines be thus taught so much, may they not also come to possess a mind, and so having, do no more work? Howbeit, such idle speculations apart, the Precedent ascribeth the free running of these devises to the good favour of the Electriks.

Thereafter he discoursed of that magic whereby the speech of a man runneth on a wire to a great distance; and lamented that divers unlearned and extra-suburban folk conceived that this great magic might be worked without the benefit of the Inner Circle. Alas! that such heresies should break forth in so fair a cult. (I would have you know that the "Suburbans" be a people of small comprehension; but they that live beyond them have no comprehension at all; the which is a hard thing to understand, seeing that they that dwell within the walls are very few.)

Then marked he the abolition of the cells at the Post-House; and, indeed, many prisons have been destroyed of late. At the close the oration turned to the casting of thoughts and signs into space; where they be caught by a net or cradle of wires, and, in their struggles, make weird marks or writings on a fair surface. By a kind of Lantern, called formerly Magick Lantern, but now Oxydrogan (which soundeth better) shadows of these writings were shown on the wall, to the astonishment and admiration of those that were watching; but by reason of age, I could not clearly descry those potent marks, which appeared to me as appeareth the northern shore of the river on a stormy evening, nigh unto the Temple, especially at times. Thereby is it to be seen that the sight of these Electriks is as keen as their understanding, for it seems they perceive the meaning of the marks.

Now, when this marvel of information was ended, rose one of very mild and amiable speech, praying pardon that he could not fully comprehend so vast a matter. (This he did, as I suppose, from courtesy, for presently he showed how he could read the magic writing, and thus was himself of the Inner Circle.) Then, with kindly thought for the baser folk, did he accord praise to all "staff," whereby so great work as they had heard of had been knocked into shape. And he called on all there present to praise their chief. They, well knowing that a lesser man would well have taken two hours to read that discourse gave great approval.

Finally spoke in defence of the Precedent, his Second, or one appointed to aid him. He saith that, howsoever ye may think, greater is he who maketh an oration than he who listeneth thereto. The which sent me away pondering.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

26,348. "Improvements in and relating to systems of connections for the operation of branch telephone stations and the like." W. OHNESORGE. Date applied for under Patents Act, 1901, December 17th, 1904, being date of application in Germany.) December 18th. (Complete.)

26,355. "Improvements in and connected with electrically-driven vacuum cleaning or dust-removing apparatus." A. HEIN. (Date applied for under Patents Act, 1901, July 26th, 1905, being date of application in Germany.) December 18th. (Complete.)

26,376. "Improvements in switching apparatus for use in electric flash advertising." L. K. JOB. December 18th.

26,434. "Improvements in fuse heads for electric blasting." F. RENDER. December 19th. (Complete.)

26,445. "Improvements in electrical signs." G. T. CLARKE and J. A. STEVENS. December 19th.

26,460. "Improvements in or relating to trolleys of electric cars and the like." J. F. MASON. December 19th.

26,461. "Improvements in joint boxes for the protection of joints of electric cables and the like." J. STRATTON and E. A. CLAREMONT. December 19th.

26,467. "Improvements in electrical apparatus for lighting gas." H. NEHMER. December 19th.

26,468. "Improvements in sparking plugs." N. W. H. SHARPE and J. P. SHARPE. December 19th.

26,501. "Improvements in electrical means for giving an impulse to a pendulum." R. M. LOWNE and THE LOWNE ELECTRIC CLOCK AND APPLIANCES CO., LTD. December 19th.

26,510. "Improved means for transforming direct electric currents." W. J. FAHN and B. JIROTKA. December 19th.

26,512. "Improvements in connection with electrostatic watt and watt-hour meters." E. WILSON and W. H. WILSON. December 19th.

26,525. "A new or improved electric shock apparatus." R. J. LOVEGROVE. December 19th. (Complete.)

26,528. "Telephone message tablet with fall-down number register." A. F. CROFTS, H. C. SMITH and G. E. WELLS. December 20th.

26,548. "Improvements in dynamo-electric machines of 'direct continuous current.'" E. TOPHAM. December 20th.

26,575. "Improvements in trolley booms of electric tramcars." J. ROBERTSHAW and T. P. ROBERTSHAW. December 20th.

26,581. "Improvements in or connected with electric radiators." C. BRIGHT. December 20th. (Complete.)

26,590. "Apparatus for generating and utilising high-tension alternating currents for the ignition of explosive mixtures in internal combustion engines." L. J. LE PONTOIS. December 20th.

26,591. "Register for telephone calls." A. E. LAMKIN and A. QUINTON. December 20th.

26,595. "Improvements in apparatus for electric signalling." A. G. BROWN and A. W. BROWN. December 20th.

26,601. "Improvements in automatic electric cut-outs." O. IMRAY. (J. A. Hoffe, Cape Colony.) December 20th.

26,629. "Improvements in or relating to connections for two or more three-phase motors." C. DE KANDO. December 20th. (Complete.)

26,631. "Improvements in electro-magnetic motors with travelling fields." H. ANDREE. December 20th.

26,662. "An improvement in electrical batteries." H. C. BRAUN. December 21st.

26,688. "Improvements in or relating to means for converting varying alternating electric current into similarly varying direct current." S. G. BROWN. December 21st.

26,689. "Improvements in or relating to the distribution and supply of current in electric railway systems." O. S. BRAGSTAD. (Date applied for under Patents Act, 1901, December 21st, 1904, being date of application in Germany.) December 21st. (Complete.)

26,691. "Improvements in or relating to thermo-electric galvanometers." C. FERY. (Date applied for under Patents Act, 1901, January 6th, 1905, being date of application in France.) December 21st. (Complete.)

26,713. "Improvements in controlling electric current distributing systems." J. L. ROUTIN. December 21st. (Complete.)

26,807. "Improvements in dynamo-electric apparatus." W. N. L. DAVIDSON. December 22nd.

26,808. "Improvements relating to alternating current motors." R. LUNDELL. December 22nd. (Complete.)

26,813. "Improvements in or relating to electrolysis of metallic compounds or ores." E. A. ASHCROFT. December 22nd.

26,828. "New or improved device for holding a writing pad upon a telephone desk or its equivalent." C. M. LOVE. December 23rd.

26,852. "Improvements in or relating to electric arc lamps." B. M. DRAKE, A. D. JONES and THE JANDUS ARC LAMP AND ELECTRIC CO., LTD. December 23rd.

26,853. "Improvements in or relating to electric arc lamps." B. M. DRAKE, A. D. JONES and THE JANDUS ARC LAMP AND ELECTRIC CO., LTD. December 23rd.

26,854. "Improvements in or relating to electric arc lamps." B. M. DRAKE, A. D. JONES and THE JANDUS ARC LAMP AND ELECTRIC CO., LTD. December 23rd.

26,855. "Improvements in filaments of incandescent electric lamps." A. BOURDOS, R. ROTHSCHILD and J. W. SUTCLIFFE. December 23rd.

26,870. "Improvements in and relating to dynamo-electric machinery." THE HON. C. A. PARSONS and J. H. ARMSTRONG. December 23rd.

26,876. "Improvements in secondary or storage batteries." A. J. BOULT. (E. V. Stebbins, United States.) December 23rd. (Complete.)

26,897. "Improvements in single-phase commutator motors." V. A. FYNN. (Date applied for under Patents Act, 1901, March 25th, 1905, being date of application in Switzerland.) December 23rd. (Complete.)

26,989. "Improvements in or relating to single or polyphase alternate current motors and generators." V. A. FYNN. December 23rd.

26,902. "Improvements in the electrolytic production of metallic sheets, tubes, wire, strip, or the like." S. O. COWPER-COLES. December 23rd.

26,903. "Improvements in or connected with anodes." S. O. COWPER-COLES. December 23rd.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

COMBINED TELEPHONE AND SOUNDING TELEGRAPH. A. H. Andersson. 22,443. October 18th.

ELECTRIC SWITCH OPERATING MECHANISM. British Thomson-Houston Co., Ltd. (General Electric Co.) 25,026. November 17th.

ELECTRIC SWITCH OPERATING MECHANISM. British Thomson-Houston Co., Ltd. (General Electric Co.) 25,027. November 17th.

MOUNTING OF STEREOTYPE, ELECTROTYPE, AND OTHER PRINTING SURFACES. J. A. Corey. 25,099. November 19th.

METHOD OF UTILISING THE LIVE WIRES OF AN ELECTRIC LIGHTING AND LIKE CIRCUIT TO CONVEY SIGNALS BY THE AID OF ELECTRIC WAVES. J. H. Lee and A. E. R. Bottone. 25,370. November 22nd.

ELECTRIC INCANDESCENT CANDLE LAMPS. P. C. Dafforn. 25,519. November 23rd.

SPACE TELEGRAPHY. J. S. Stone. (Date applied for under International Convention, November 25th, 1903.) 25,645. November 24th.